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THE MAGAZINE OF MATERIALS ENGINEERING

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NEXT MONTH: Selecting Steels for Low Temperatures . . . . New One-Coat Porcelain Enamel . . . . Heat Treating Rocket Bodies . . . . Descaling Steel by Induction . . . . New Ceramic Material . . . . Spring Materials . . . . Plastic Potting Compounds . . . . Fluids for Hydraulic Systems . . . ANNUAL MATERIALS ENGINEERING REVIEW (Materials & Methods Manual No. 78)

"How'd you like to save $1.50 on every one of those packages?," asked Ed

Two men stood watching the steel unloading operation. "Say Dave—aren't those 6,000 pound lifts you're using?"

Ed Browning, an Inland "trouble shooter" on shipping and handling problems, was visiting the plant of a large manufacturer of hydraulic hoists and dump bodies. This customer had been ordering 42" x 96" hot rolled sheets from Inland in 6,000 pound lifts. As he stood on the unloading dock with Dave Nordstrom, the customer's purchasing agent, Ed observed that the practice was to remove only a few sheets at a time from the lift because their equipment couldn't handle a complete package that heavy.

"Yes, Ed, those are 6,000 pound packages. Why?"

"I'll bet that's a holdover from old packaging prices. If you can use 10,000 pound lifts, you'll save $1.50 on every package."

"Well," said Dave, "we can soon find out." A check with the receiving foreman confirmed that it would be just as easy to break down five ton as three ton lifts for unloading.

Result: The very substantial saving of $1.50 per lift on the large volume used by this Inland customer. INLAND STEEL COMPANY, 38 S. Dearborn St., Chicago 3, Ill.

Names used are fictitious

The Materials Outlook

Confusion is the watch word in the whole materials controls picture. Washington has tried to control too much, with too little actual power and too little cooperation. . . . International price fixing in zinc and copper have met a wall of polite smiles. Result: U. S. imports have dropped off in both metals. . . . The same story is in the cards for tin. . . . Even NPA authorities wonder if extending controls (to inventories, for example) would not compound the foul-up.

The last month of 1951 will be tough on industry. Civilian goods will be cut back drastically and most materials supplies will not ease up much. By January, the industrial picture will begin to brighten by release of materials thus saved. Materials supplies will blossom and defense production (instead of planning) will be rolling. . . . Next year will see most fabricators getting an adequate supply of some materials. The materials menu may be pretty plain though, and unpleasant adjustments will continue. . . . For the consumer, next year will be the beginning of real trouble. Inventories are going down now, and consumer product shortages look inevitable.

Columbia University is undertaking a research project on boundary conductance in quenching. This work will pin point the mechanisms of heat transfer in quenching and determine the exact properties of various quenching media under all circumstances. Most of the rules used now in quenching are estimates based on what each firm thinks its experience proves.

Silicone rubber treated glass cloth for electric motor and cable insulation is now in production at GE's Coshocton, Ohio, plant. Widths of 36 in., in 4- to 10-mils thicknesses, are being produced. The company expects new electrical applications to take much of the new production.

Prices on silicone-alkyd coating resins have been cut 14 to 38% by the Plaskon Div. of the Libby-Owens-Ford Glass Co. Company officials think that silicone-alkyds will continue down costwise until they compete with standard organic coating resins.

Rigid polyvinyl chloride (non-plasticized form of the material) is now supplied in sheets, tubes, bars and molding powder. It can be welded, machined and formed. There is no aging phenomenon, and the material resists almost all acids and alkalies, and many special chemical solutions. A

(Continued on page 4)

The Materials Outlook *(continued)*

big attraction for designers is the fact that rigid polyvinyl is equal to aluminum in tensile strength and weighs only half as much.

The 1300 steel alloys are more readily available than many of the richer specifications. They are tougher to machine and heat treat than higher alloys, but with the right care they can give equivalent service. . . . One of the automobile companies has been using the 1300 steels right along and has a considerable amount of data collected. This company has not made the data public, however, for fear the supplies might dry up under a herd of new buyers.

A relatively new process makes nonferrous forgings which can be cored from four sides in the same plane in one operation. Substantial savings are promised in small- and medium-sized parts. Savings are achieved through reduced machining and finishing and by significant reductions in materials requirements through reduced scrap losses. The method is now being used for padlock bodies, high pressure valve bodies, oil burner valves, steam trap bodies and fire extinguisher parts.

A special extruded vinyl slide fastener has been designed for vinyl garment bags, cosmetic kits and other small items. Unlike metal-toothed slide fasteners, the vinyl mechanism is as rust-proof and water-proof as the sheeting itself. The fastener consists of two identical ribbed tapes, which are brought together and engage each other as the slide moves along the seam.

Several new applications of polystyrene are growing rapidly. High-impact polystyrene pipe cannot be used universally (not in petroleum fields, for instance), but for mine pipe it does fine. Furniture and military housing piping are good applications. Low temperature brittleness is still a problem, but this should be solved soon. . . . Polystyrene phonograph records are also making progress. Eventually, they are expected to take over a good part of the market. . . . Bristles are also doing well, and extruded glass-filled styrene laminate is also being developed.

A materials conservation item that was imported from Germany is a copper-clad alumminum bus bar. Bus bars have been big users of copper, and this combination construction looks like a good hedge. . . . Copper-clad aluminum is now being produced in this country for electronic tubes, jewelry and other applications where copper has been the conventional material.

A modified step-quench treatment that has been developed quenches steel from above critical temperature to a point above the temperature of martensite formation. The steel is held here for a time insufficient to permit transformation to austenite, then hot worked by blasting, peening, rolling, swaging, hammering, burnishing or forging. The treatment combines and accentuates the advantages of step-quenching and shot-peening.

See page 7 for "Materials Control Order"

Materials Control Orders

A summary highlighting actions of the NPA affecting engineering materials during the period from Oct. 11, 1951 through Nov. 10, 1951.

CONTROLLED MATERIALS PLAN

Dir. 7 to Reg. 1, Dir. 3 to Reg. 6—Users of steel, copper or aluminum must have adjusted or cancelled outstanding orders for these materials by Oct. 31 so that total deliveries (including those made under fourth-quarter allotments) received after Oct. 7 would not exceed fourth-quarter allotments.

ALUMINUM (CMP Reg. 2, Dir. 3 to M-5, M-88)

Inventories of all manufacturers must be reduced from a 60-day to a 45-day supply. Those with A-1 allotment symbols engaged in the military aircraft program are excepted and may maintain 60-day supplies. Any having outstanding orders which would boost their inventories above the permitted limit upon delivery must cancel the excess or adjust delivery dates to conform. Producers must consider all shipments to customers made after Oct. 7 as having been shipped under fourth-quarter allotments. Any such shipments made under third-quarter allotments must be deducted from allotments for the fourth quarter. Aluminum distributors are permitted to place orders with producers to replace stock sold during the preceding month to fill authorized controlled material orders. They may also replace 5% of their stock sold under non-rated orders. They may reject orders calling for delivery to individuals, at any one time, of more than 1000 lb of sheet or plate, or more than 300 lb of wire, rod, bar, tubing, extrusion or structural shape.

COLUMBIUM (Order M-80)

Use of columbium permitted in manufacture of Class A and/or Class B products required by Department of Defense or AEC programs. Certification by the Aircraft Production Resources Agency is required for deliveries of columbium alloy steels for the aircraft program. Columbium-coated welding rod is now classified as a columbium-bearing steel.

COPPER (Orders M-11, M-16, M-82)

Copper producers need no longer keep 15% of their production in reserve. They may accept up to 100% of their authorized monthly production in CMP orders. Suppliers must notify users promptly of the acceptance or rejection of orders. Producers must open their books for orders not later than 90 days in advance of a new quarter. They may determine which orders they will accept without regard to dates of receipt, except in the case of direct military or AEC orders. During the final 15 days before the expiration of lead times, however, they must accept all ACM orders on a first-come-first-serve basis.

Anticipated Changes: Proposal would broaden M-82 to permit distributors to deliver up to 10,000 lb of condenser tubing on any one order without NPA approval. A new direction to M-16 now being prepared will authorize foundries, brass mills and ingot makers to obtain advance allotments of materials up to 50% of the quantity received during the previous month.

IRON AND STEEL (Dir. 8 to CMP Reg. 1, Orders M-1, M-6A)

Consumers with allotments of steel for a given quarter may order finished conversion steel by ordering from a finished conversion steel producer. They may not order semi-finished conversion steel in greater quantity than that needed for processing into finished products in the amount alloted by the NPA. Commencing Jan. 1, 1952, producers must accept orders from distributor-customers for shipments of aircraft quality alloy steel products up to a minimum of 100% of tonnages shipped during the base period Apr. 1, 1951 to June 30, 1951. Distribution of aircraft quality alloy steel products is prohibited unless: (1) the product is for aircraft guided missiles or airborne equipment necessary for production, maintenance or repair; (2) the allotment under which the product is ordered bears the symbol E-2. Steel producers need no longer retain 10% of their output in reserve but may now accept CMP orders for up to 100% of their authorized monthly production. Producers must accept orders for an approaching calendar quarter not less than 45 days before the beginning of the quarter. Where CMP orders cannot be placed, the Iron and Steel Div. of NPA will assist in locating sources of supply.

LEAD (Order M-76)

The NPA is allotting imported, as well as domestically produced, pig lead to consumers. As of Nov. 1, no person may accept delivery of soft primary pig lead or imported pig lead for any purpose other than in accordance with monthly NPA allocations. Persons importing pig lead for resale without change of form must report to the NPA the quantity, grade and country of origin of the lead involved at least 15 days prior to the first of the month in which the shipment is expected to arrive.

RUBBER (Order M-2)

Residue rubber is no longer under allocation control and need not be charged against synthetic rubber allocations. GR-S plant clean-up rubber will still be charged against synthetic rubber as previously.

TANTALUM (Order M-80)

Use of tantalum in Class A and/or Class B products for Department of Defense or AEC programs is permitted. Certification by the Aircraft Production Resources Agency is required for deliveries of tantalum alloy steels for the aircraft program.

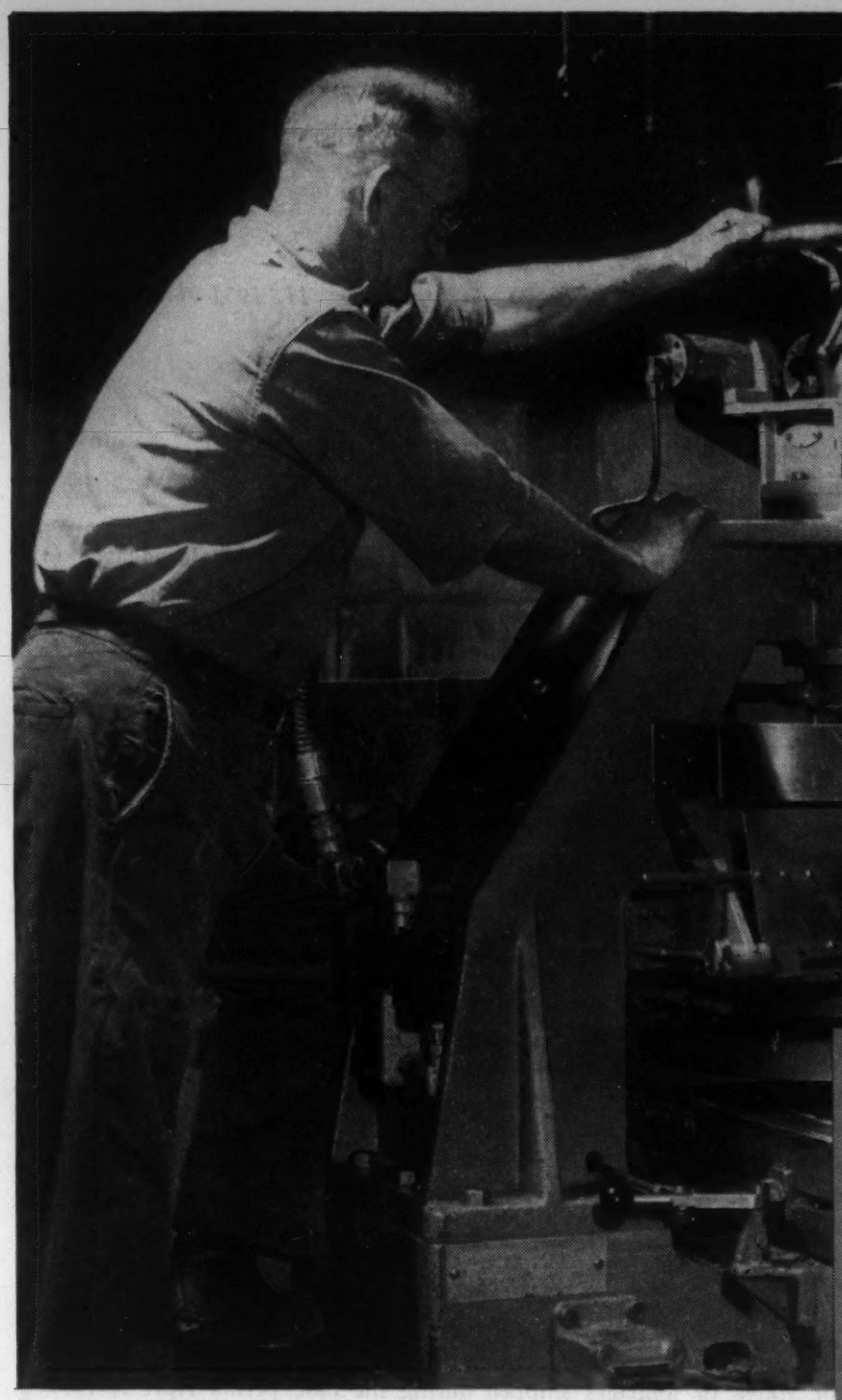
THIOKOL (Order M-45, Sched. 10)

As of Nov. 1, thiokol is allotted under Appendix A, thereby making some of the supply available to civilians.

NPA REGULATIONS

Reg. 1, Amended, Int. 1, 2 and 3 Amended: Many products and materials have been added to Table 1A of Reg. 1, thereby restricting the inventories of such products where they had not been before. The newly-added Table 1B imposes specific calendar-day supply limitations or practicable minimum working inventories, which are less, on certain materials. The definition of items in inventory now includes items formerly classified as "in process".

Reg. 6: Where the ownership of a going concern is transferred, the new owner may use all NPA quotas and privileges of the former owner provided the nature of the business does not change. The new owner is, of course, subject to all of the restrictions of the former owner.



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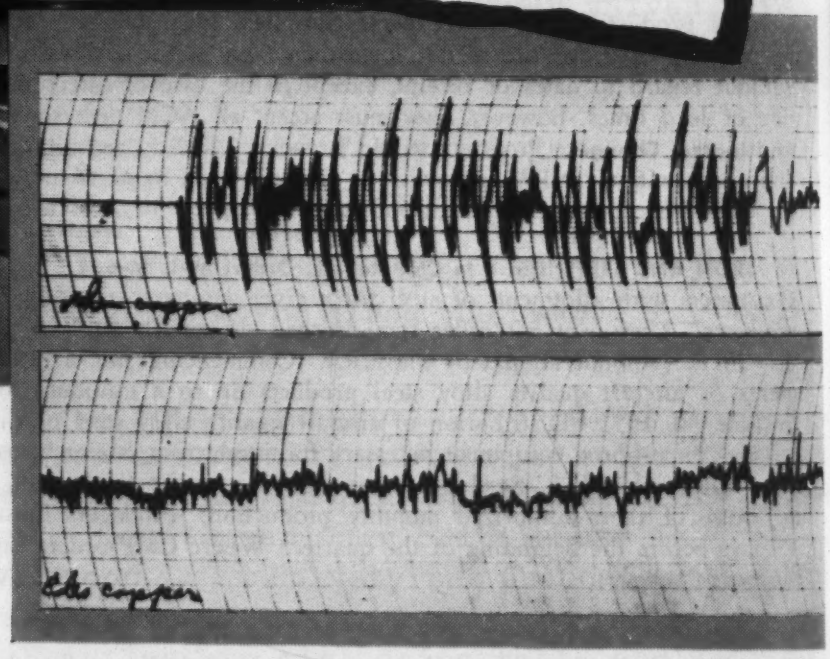

Diamond surfacing machine in the Edes plant, producing a perfect surface on a Revere Copper Sheet.

Charts showing typical surfaces. Top, ordinary copper plate. Bottom, a diamond-finished Edes plate. It takes fine copper to produce this result.

• One of the country's best-known suppliers of copper plates for photoengraving is The Edes Manufacturing Company, Plymouth, Mass. Edes has developed a patented process that is unique for giving plates the final polish. They are surfaced with diamond cutters, specially cut and ground. The plates thus produced and shipped to photo-engravers have an accuracy of plus or minus .00025 inch, practically dead flat and true to gauge at any point within these limits. Obviously, only exceptional copper will do.

Making copper sheets for this service is an exacting process. The metal as supplied by Revere must be specially handled in the mill to make sure there are neither surface nor imbedded imperfections, since a pin-point defect in the finished plate will show in printing.

Revere has always taken a deep interest in the graphic arts, not only because the industry is a good market for copper, but also because Paul Revere himself was a skilled engraver on copper. Thus it is likely that the original plates for this advertisement were of Revere Copper, and also many of the plates used by the magazines you read. In addition, Revere supplies copper rolls for rotogravure, the comics, and for textile printing. For fine copper for graphic processes, consult Revere.

REVERE 150th YEAR OF SERVICE TO AMERICA

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere

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News Digest

Materials Parley Allots Nickel and Cobalt

The 28-nation Raw Materials' Conference has decided to allocate scarce nickel and cobalt among 32 anti-Communist nations and areas. The United States was assigned 62% of available nickel supplies and 59% of cobalt stocks to feed its expanding defense and civilian industries.

The allocation plans were announced after nearly six months of negotiation by a 12-country committee which surveyed world-wide production and consumption prospects. The success of the allocation scheme will depend on voluntary cooperation among participating countries.

U. S. Rubber Stockpile Held Ample

The president of the United States Rubber Co. has announced that he is convinced the United States has a safe rubber stockpile.

"I believe we could face a 5-year war, even with our Far Eastern supply entirely shut off", H. E. Humphreys, Jr. told the National Association of Independent Tire Dealers. Rubber available next year, both natural and synthetic, will exceed consumption by more than a quarter of a million tons, he said, adding that "more rubber will be available for civilian goods than in 1951."

He called on the government to get out of the rubber business; to turn over the synthetic rubber program to private industry and permit rubber buying in the open market. If this were done, he predicted, the price of natural rubber could be expected to drop from around 50¢ to 15 to 20¢ a lb.

Actual stockpile figures are secret. Six weeks ago a government official said the stockpile goal is "not too distant, assuming normal market conditions."

Steel Producers See Balance in Steel Supply

A turn for the better, from the consumers' point of view, is being predicted by many men in the steel industry. These authorities claim that the effects of government controls have obscured the real picture in steel supply.

Steel Surplus

E. G. Grace, Chairman of the Bethlehem Steel Corp., said that inquiries for structural steel have declined, week by week, since April. The demand for conversion steel is also falling off, he added, and there will soon be over-capacity for making cold-rolled sheets which until recently have been in tight supply.

According to recent Government estimates of the demand for specific steel products, structural steel represented the most critically short item. The Government has said that stated requirements for structural steel shapes amounted to 223% of the estimated supply. Mr. Grace pointed out that Bethlehem is the largest factor in this form of steel in the nation. Inquiries, he said, have been very light in recent months, and since April production has cut into backlogs for mill and fabricated products. A continuation of this trend, he pointed out, must soon be reflected in reduced operations.

Mr. Grace cited as an example of the wide discrepancy between requests for steel filed with the National Production Authority under the Controlled Materials Plan the fact that demand for structurals was fully satisfied with 80,000 tons in the September quarter against original requests of 183,000 tons. In the case of Bethlehem, he said, the third-quarter order book for structurals was barely filled at the month's end. The company, meanwhile, is not behind in a single order in its structural book and is making prompt deliveries on every project.

John E. Timberlake, general sales manager of the Jones and Laughlin Steel Corp., testifying before the Senate Small Business Subcommittee in Pittsburgh, reported that the demand for steel generally has been declining and that some products now require a real selling job. Mr. Timberlake observed that some over-inventories of steel have been accumulated, adding that there must be a lot of inventory, both processed and unprocessed, that has not been assembled.

Structural Demand

An optimistic picture of the availability of structural steel for 1952 construction was also presented by J. V. Honeycutt, assistant vice president, Bethlehem Steel Co., before the convention of the American Institute of Steel Construction. The average tonnage booked by the construction industry "has been going down since April," he stated, and "the backlog of the orderbook is decreasing."

Granting that buyers' requests to the Defense Production Administration for structural steel shapes in the first quarter of 1952 are virtually double previous record consumption, the speaker said "these stated requests are greatly inflated, are highly misleading, and are far from being realistic."

The high volume of requests he attributed to the eagerness on the part of claimants to get allotments for steel in the earliest quarter. The American Institute of Steel Construction figures on September bookings of fabricated structural steel totaled 188,013 tons, off 11% from the 212,256 tons booked in August and comparing with 317,225 tons for September 1950.

Government Controls

The major factor in the current maldistribution of steel is the government-controlled economy, R. D. Wood, president of the American Institute of Steel Construction claims. Maldistribution of steel, Mr. Wood declared, is the result of changing normal trade practices by placing distribution in the hands of the National Production Authority. The very nature of the steel industry makes this detailed and centralized control difficult, he added.

These steel bogie wheels needed on all U. S. Army half-tracks undergo inspection at The B. F. Goodrich Co. in Akron, before solid rubber tires are vulcanized to rims.

Radioactive materials, hidden behind a concrete wall, can be studied with this microscope developed for scientists at General Electric's Knolls Atomic Power Laboratory by the American Optical Co.

Lewyt Corp. Making Own Parts to Assure Profit on Government Contracts

For the first time the Lewyt Corp. has started making its own components and parts for industrial contract products. A booming parts and components market has forced the company to take this unprecedented step to make a profit on military contracts, according to Alex Lewyt, president.

$10,000,000 Signal Corps electronic equipment contract was awarded to Lewyt prior to outbreak of the Korean war. Mr. Lewyt, emphasizing that the low bid submitted at the time cannot and will not be altered, said meeting it was predicated on components and parts costs before Korea. The company has no choice but to make its own components and parts because booming prices since Korea would rule out an operating profit if they were purchased from suppliers.

The Lewyt bid was based on purchase of such items as quartz crystals for $1.70 each. The current going market price is about $3, Mr. Lewyt pointed out.

Transformer prices are up 15 to 20%, but by manufacturing the components itself the company is reducing transformer costs 25%, Mr. Lewyt said. Transformer production already has begun, and variable condensers also are being made at appreciable savings.

The company probably will turn out quartz crystals soon, Mr. Lewyt stated. He explained the items are made "by the handfuls" in times of peace and are in heavy demand only when Government electronic requirements are staggering. A technical problem in shifting to mass production is involved, but Mr. Lewyt expressed confidence that it can be achieved by his organization.

● The Glidden Co. of Cleveland has started commercial production of a new white silicone enamel known as Nubelon. The enamel is for household appliances.

Aluminum Automobile Engines at Road Test Stage

The Kaiser Frazer Corp. reports that experiments with aluminum engines have reached the road test stage. The program was started five years ago, and the engines studied range from valve-in-head four- and six-cylinder designs to V-6's and V-8's. The horsepowers and compression ratios used varied widely.

The object of this research is to save weight in engines. Reductions of more than 50% seem possible with the use of aluminum. Substantial gains are expected in automobile performance and fuel economy. Experiments on the use of aluminum in clutch housings are also under way.

Hoover Given Coonley Medal and Citation

Former President Herbert Hoover received the Howard Coonley medal of the American Standards Association in recognition of his work to reduce waste, improve efficiency and increase production through standards. The award was presented at the New York meeting of the Association.

The citation accompanying the award to Mr. Hoover said in part: "As an engineer, as a public servant rising to the highest office in the land, he has for more than half a century labored to reduce waste, improve efficiency and improve production through standards".

With reference to the non-partisan commission on government organization, of which Mr. Hoover was chairman, the citation said: "As chairman of the greatest effort ever made to plan an efficient, economical reorganization which has come to bear his name, he called the attention of the world to standards as a key to administration."

● Shortages of copper, steel and steel alloys now threaten the electric power industry with loss of 4,000,000 kilowatts of projected expansion in capacity by the end of 1952 and as much as 7,000,000 kilowatts by the end of 1953, according to George M. Gadsby, president of Edison Electric Institute.

Rare Earth Ores to Be Mined in California

Molybdenum Corp. of America has acquired properties in California believed to contain the world's largest deposits of some 14 rare earth minerals, according to an announcement by Max Hirsch, president. Most important of the minerals concerned, Mr. Hirsch said, are cerium, lanthanum, ittrium, gadolinium, sarmarium and neodymium, all used as dioxidizing agents in the production of stainless steel.

Mr. Hirsch said that the company, through extensive exploration and drilling, has developed a large tonnage of ore of good grade which can be mined through surface or open pit operations. A mill adaptable to the benefication of the ore is on the property, and it is the intention of the Molybdenum management to begin active production as well as further to develop the ore bodies.

The property is a tract measuring about 3 by 1½ miles in eastern California near the Nevada border. Preliminary drilling has indicated that the rare minerals contained in the deposits are comparable in size or larger than existing deposits worked in India and Brazil. Some minor finds also have been made in recent years in Florida and Idaho.

● The Defense Production Administration has settled tentatively on the figure of 950,000 automobiles as the production ceiling in the first quarter of 1952, a cut of 13% from present output.

Anaconda Copper to Make Aluminum

Anaconda Copper Co. has decided to go into the aluminum business.

Whenever the Government gives its approval, the big copper producer is ready to finance the construction at Kalispell, Mont., of a $40,000,000 plant capable of turning out 54,000 tons (108,000,000 lb) of aluminum ingots annually.

Announcement of the decision of Anaconda, the world's largest producer of copper, to enter the aluminum field was made by Cornelius F. Kelley, chairman of the company, following reports that Anaconda and the Harvey Machine Co. of Torrance, Calif., had formed a partnership to build the Montana plant. The Harvey Co., unsuccessful in its quest of a $46,000,000 R.F.C. loan to finance the Kalispell operation, will have a small minority interest in the undertaking, according to the Anaconda chairman. The entry of Anaconda into the aluminum field would obviate the need for any direct Government financing.

Long Shortage of Container Metal Forecast

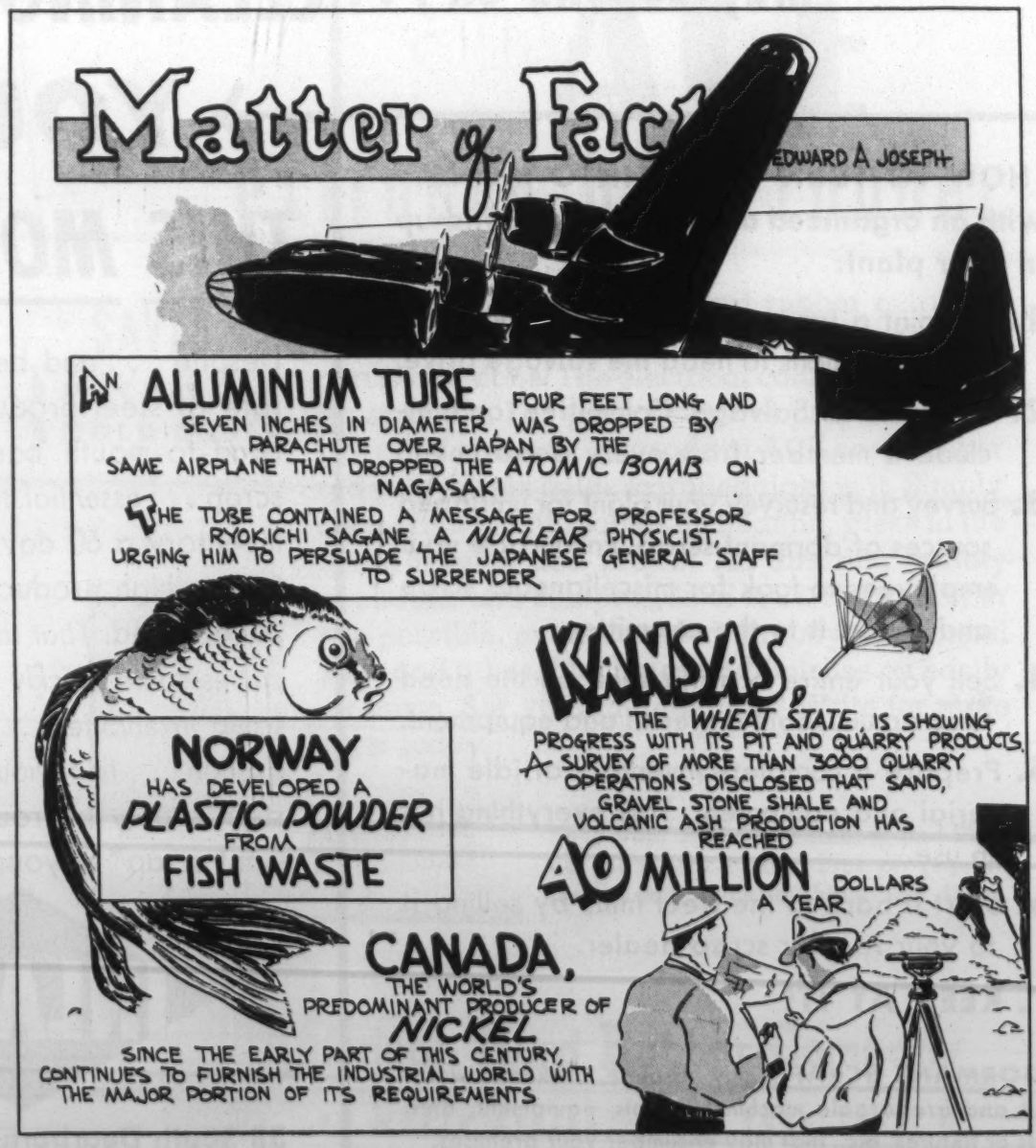
Metal shortages will continue to plague the packaging industry for many months, although increased output of aluminum may result in an easier supply situation in the third quarter of 1952, and zinc, lead and carbon steel supplies should rise some time in 1952, Robert deS. Couch, director of the National Production Authority's Container Div., has announced.

Speaking at the annual meeting of the Packaging Institute, Mr. Couch pointed out that in general there would be less steel available for containers in the first quarter of 1952 than previously. Stainless steel and various other alloys of steel will be very short for some time to come, he said. Owing to the increase in the small arms ammunition program, brass will also be in extremely short supply for many months, Mr. Couch stated.

Henry Griffith, of Plax Corp., said that some improvement could be expected in 1952 in supplies of polyethylene, while R. S. Jones, of Dobeckmun Co., plastics film converters, reported that demand for cellophane would probably continue to exceed supplies next year. The recent sulfur restriction order will reduce supplies of cellophane, Mr. Jones stated.

(More News on page 13)

News Digest



Continued high steel production this winter may depend on . . . CLEANING OUT → YOUR SCRAP THIS MONTH

HOW TO TURN SCRAP INTO MONEY with an organized dormant scrap round-up in your plant:

1. Appoint a top executive with authority to make decisions to head the salvage drive.
2. Organize a Salvage Committee and include a member from every department.
3. Survey and resurvey your plant for untapped sources of dormant scrap. Encourage your employees to look for miscellaneous scrap and report it to the committee.
4. Sell your entire organization on the need to scrap unusable material and equipment.
5. Prepare a complete inventory of idle material and equipment. Tag everything not in use.
6. Start it back to the steel mills by selling it to your regular scrap dealer.
7. **KEEP AT IT!**

***DORMANT SCRAP** is any obsolete, broken or worn-out and irreparable machinery, tools, equipment, dies, jigs or fixtures, etc., that may encumber your premises.

Despite . . . and because of . . . the continued high rate of steel production, the steel industry is on a hand-to-mouth basis in its receipts of purchased scrap . . . *essential to production!* Mills that normally inventory a 60 day supply of scrap, are now maintaining high production with less than a week's supply on hand. *That the effect of winter on transport facilities could quickly exhaust these dangerously meager scrap inventories . . . and thus force a cut in steel production . . . is obvious.* Help assure an uninterrupted steel supply by rounding up and selling your dormant scrap* to your regular scrap dealer *this month!*

INLAND

INLAND STEEL COMPANY

38 South Dearborn Street • Chicago 3, Illinois

News Digest

continued from page 11

Steel Founders' Society Publishes Manual on Casting-Welding

As part of its continuing research and development program, Steel Founders' Society has just published a comprehensive new manual incorporating most advanced technical data on welding of steel castings.

Based on exhaustive studies carried out by the Society, member companies, and professional research engineers, the 40-page report, "Recommended Practice for the Welding of Steel Castings", comprises a valuable guide for steel foundries and related industries to use in establishing reliable welding procedures and experience-proven quality standards.

Recognizing that welding on occasion becomes an integral operation in the manufacture of steel castings, the manual likewise recognizes that industry also is actively engaged in cast-weld construction techniques (welding steel castings together to form an integral unit), and in fabrication of engineering structures through the welding of steel castings and wrought steel products (composite fabrication). Procedures outlined in the manual thus are equally adaptable to the needs and problems of the fabricator as well as the foundry.

● The relative shortage of industrial diamonds for defense work may be eased by the opening of a French-American enterprise in the heart of French Equatorial Africa, with the aid of a $700,000 ECA loan.

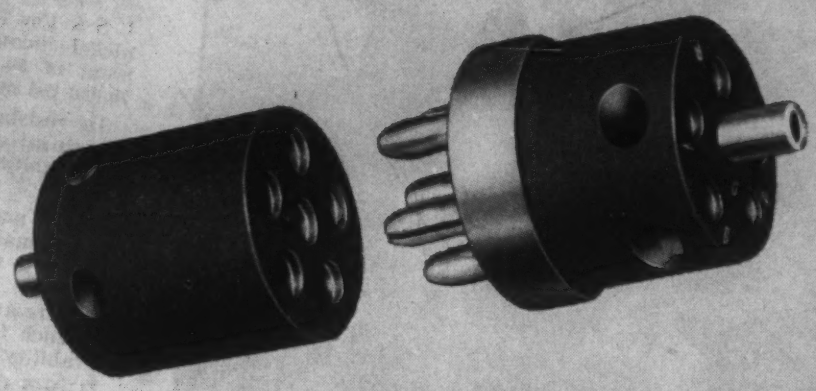
Commerce Department Issues Bibliography of Technical Reports

The research work done by the National Advisory Committee for Aeronautics provides help to America's businessmen in many fields, according to the feature article in the Sept. 1951 issue of the *Bibliography of Technical Reports*, which has just

(Continued on page 178)

where HARD RUBBER is right... use it!

how to SIMPLIFY DESIGNS



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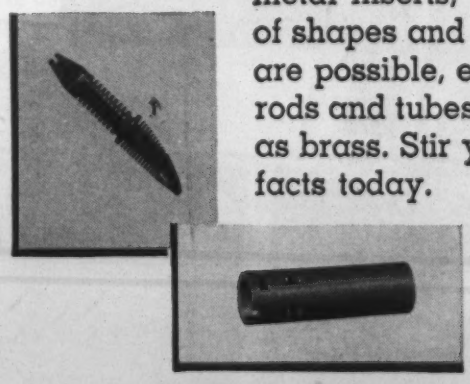

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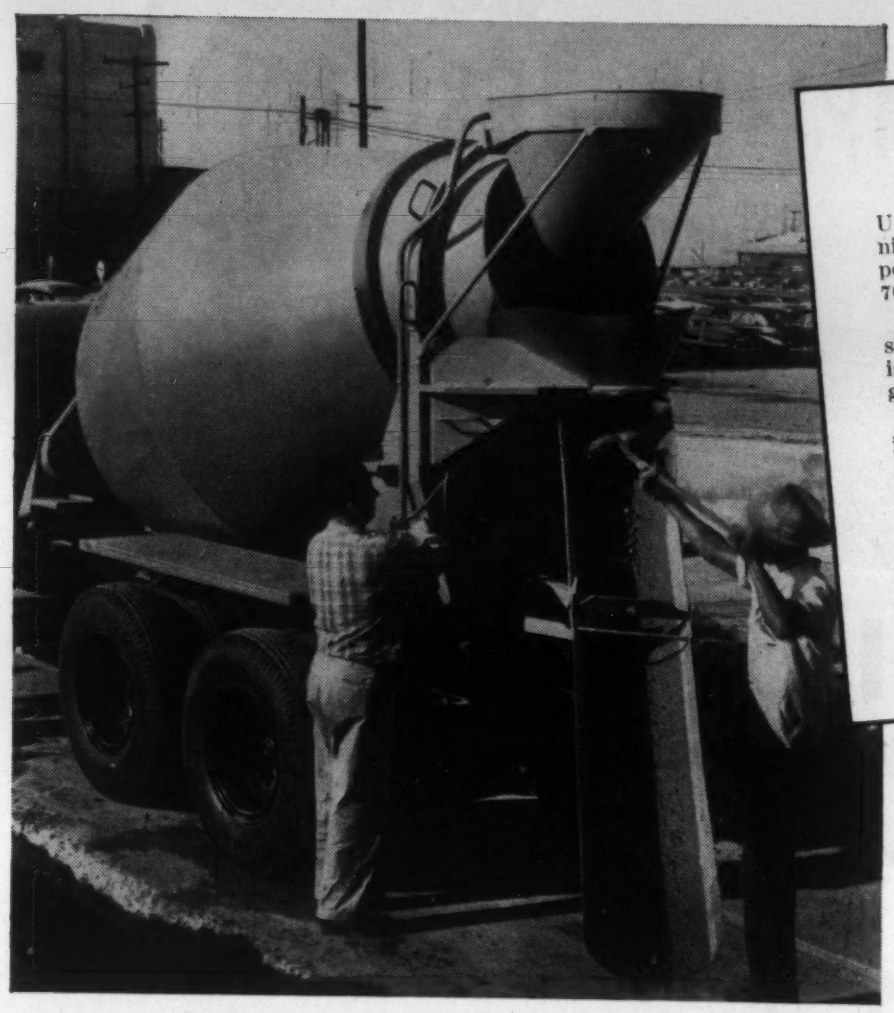
Design your equipment



"We prefer U·S·S Cor-Ten," says Mr. Ross Castendyck of the Challenge Mfg. Co., Maywood, Cal., "because of its superior corrosion and abrasion resistance as well as its high strength. These permit us to reduce our Mixer weight 10% to 15% and at the same time to build a 20% stronger unit that will stay in service at a lower maintenance cost."

U·S·S COR-TEN

U·S·S Cor-Ten is a ductile, low-carbon chromium-nickel-silicon-copper-phosphorus steel having a yield point of 50,000 psi min., and a tensile strength of 70,000 psi min. in thicknesses ½" and under.

Its resistance to abrasion and shock is superior to structural carbon steel; its fatigue resistance—that is, its ability to withstand repeated stresses—is 60% greater.

What particularly distinguishes U·S·S Cor-Ten is its unusually high resistance to atmospheric corrosion—4 to 6 times that of plain steel, 2 to 3 times that of copper steel. This property helps to assure the long life and low maintenance cost of any equipment in which Cor-Ten is used, whether to obtain greater durability or to reduce weight.

U·S·S Cor-Ten is produced in all standard products—plates, shapes, bars, sheets, strip, special cold formed sections and wire. Recommended particularly for application in light and intermediate thicknesses.

U·S·S MAN-TEN

U·S·S Man-Ten is a grade of manganese-copper steel that, at relatively low cost, provides toughness, workability and weldability in a higher degree than obtainable in carbon steel of the same strength level. Its atmospheric corrosion resistance is slightly higher than that of copper steel.

U·S·S Man-Ten, in thicknesses up to ½" inclusive, has a yield point of 50,000 psi min. and tensile strength of 75,000 psi min. Its abrasion resistance is greater than that of structural carbon steel (ASTM A7); its resistance to sudden shock is about 20% greater; its fatigue strength is approximately 40% higher, insuring greater ability to withstand vibration and reversal of stresses.

U·S·S Man-Ten is produced in plates, shapes, bars, sheets, strip, special cold-formed sections and other forms. It is particularly recommended for use in light and intermediate thicknesses.

U·S·S Tri-Ten has long been used to assure the dependability for which Caterpillar equipment is famous. The weight-saving and space-saving advantages in proportion to the strength of this steel has resulted in their engineers using it regularly.

Materials & Methods
DECEMBER 1951

Advantages of Designing with Gray Iron Castings include:

- *Efficient metal placement*
- *Flexibility in design and production*
- *Attractive appearance*
- *Complex parts produced as integral unit*
- *Low unit cost*
- *Wide range of properties*

by C. O. BURGESS, Technical Director, Gray Iron Founders' Society, Inc.

● THE CASTING PROCESS, particularly as concerns utilization of gray iron, has proved one of the most flexible manufacturing methods. About 12,000,000 tons of gray iron castings are annually employed in thousands of uses. There has been a steady growth of over 40% in annual volume of such castings during the last ten-year period. Despite the size of the industry, it is common experience that the circumstances dictating the use of casting rather than other competitive metal forms are not understood by some engineers and designers and only imperfectly recognized by others.

Therefore, an attempt will be made here to describe the casting method on the basis of three points normally of maximum interest to engineers and designers: (1) Improved operational or functional quality which may be conferred on the product by use of castings. (2) Economic advantages of the casting process as a manufacturing method. (3) Position of gray iron vs other cast metals.

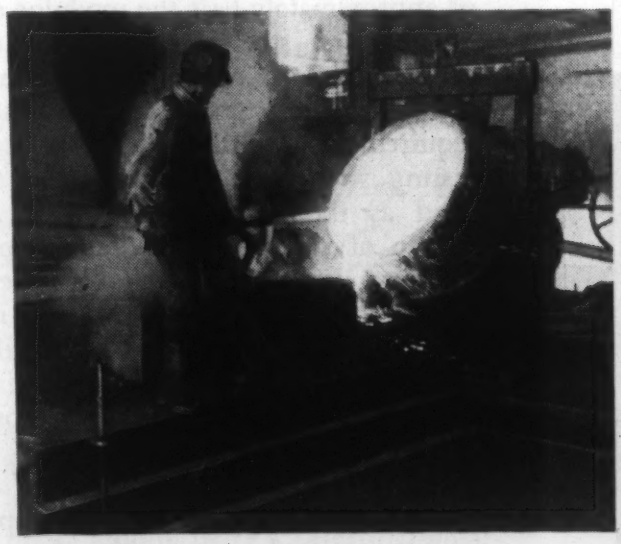
Functional Advantages of Castings

Discussed below are typical product requirements that immediately suggest the use of castings rather than other metal forms.

Rapid translation of a design into a finished product. The casting process involves essentially pouring molten metal into a cavity representing either exactly or within close tolerances the final dimensions of a desired product. This basic advantage exists whether very small or very large castings are produced and without regard to their complexity.

External shape and size suited to function. Sand castings from a few ounces to hundreds of tons in weight can be readily produced in almost any shape or any complexity desired. Some designs, in fact, can, from a practical standpoint, only be produced as castings. The only real limitation is ability to produce the shape needed in a wood, plaster or metal form used as a master pattern in molding. This molding process, for example, permits the use of undercuts and curved, reflex contours. This design flexibility should not obscure the fact that it is always advisable for casting purchasers to consult with the foundryman during the design stage.

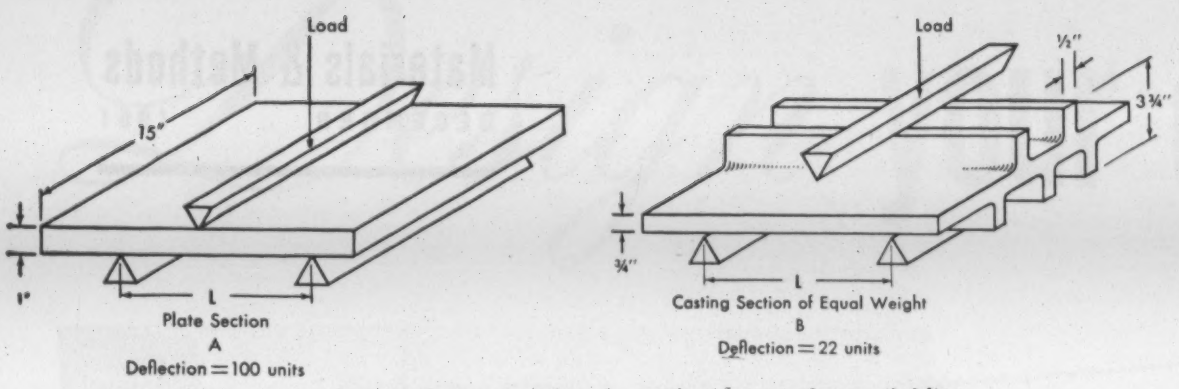
There are a few general precautions worthy of note. Large, flat, thin sections (under 1/16 in. thick as-cast), although feasible from a molding standpoint, are normally avoided in a casting as they usually present problems in feeding, and except for



The casting process permits rapid translation of a design into a finished product.

limited areas, such as cooling fins, etc., heavier wall sections should be specified. Parts as small as shuttles have been successfully cast in gray iron in competition with other methods, but obviously, a minimum size exists below which production methods, other than casting, become competitive or desirable. Except in such special cases, the known economic advantages of castings must be carefully considered by the design engineer.

Metal placement for maximum efficiency and rigidity. As casting design



Use of design freedom in casting for maximum rigidity.

does not depend on any subsequent forming process, the optimum amount of metal can, from the outset, be placed in the best location for maximum strength, wear resistance, etc., and omitted where it is not required. This design freedom, combined with ability to core out unstressed sections, often permits appreciable weight savings.

Maximum rigidity in the final section is, of course, primarily a matter of designing a section of the desired shape. This principle is illustrated in the accompanying sketch. If a load is applied to both casting B on the right and plate A on the left, the casting, although equal in weight, will only deflect approximately one-fifth as much as the plate. It is clear that even if the softest type of iron of approximately half the modulus of elasticity of steel were selected to meet maximum machinability, thermal shock resistance, or castability requirements, the illustrated gray iron casting would still be 2½ times as rigid as the steel plate section. A section of design B or other section contours needed to develop a given rigidity can be produced at will in the casting process, but would be difficult and, by comparison, unreasonably expensive to produce by most fabricating methods.

Attractive product appearance for maximum sales appeal. Because shape is not restricted to assembly of preformed pieces, casting promotes development of attractive designs. It is a fortunate circumstance that the smooth, graduated contours and streamlining essential to sales appeal usually coincide with conditions for easiest molten metal flow in a casting, the prevention of stress concentration on solidification, and minimum residual stress in the final casting.

Production of complex part as a single integral unit. The design freedom inherent in the casting process enables the designer to obtain a very intricate part in a single piece; *i.e.*, combine what would normally be several parts in one unit casting. This is of particular significance when exact alignment must be held, as in high-speed machinery, machine tool parts, or engine end plates and housings that carry shafts.

One-piece construction also eliminates joints, and thus the possibility of oil leakage, water leakage or accelerated corrosion at such joints. An engine block exhibiting an involved outer shape and a number of intricate internal passages is one of the most obvious examples of combining a group of normally independent elements into a single integral casting.

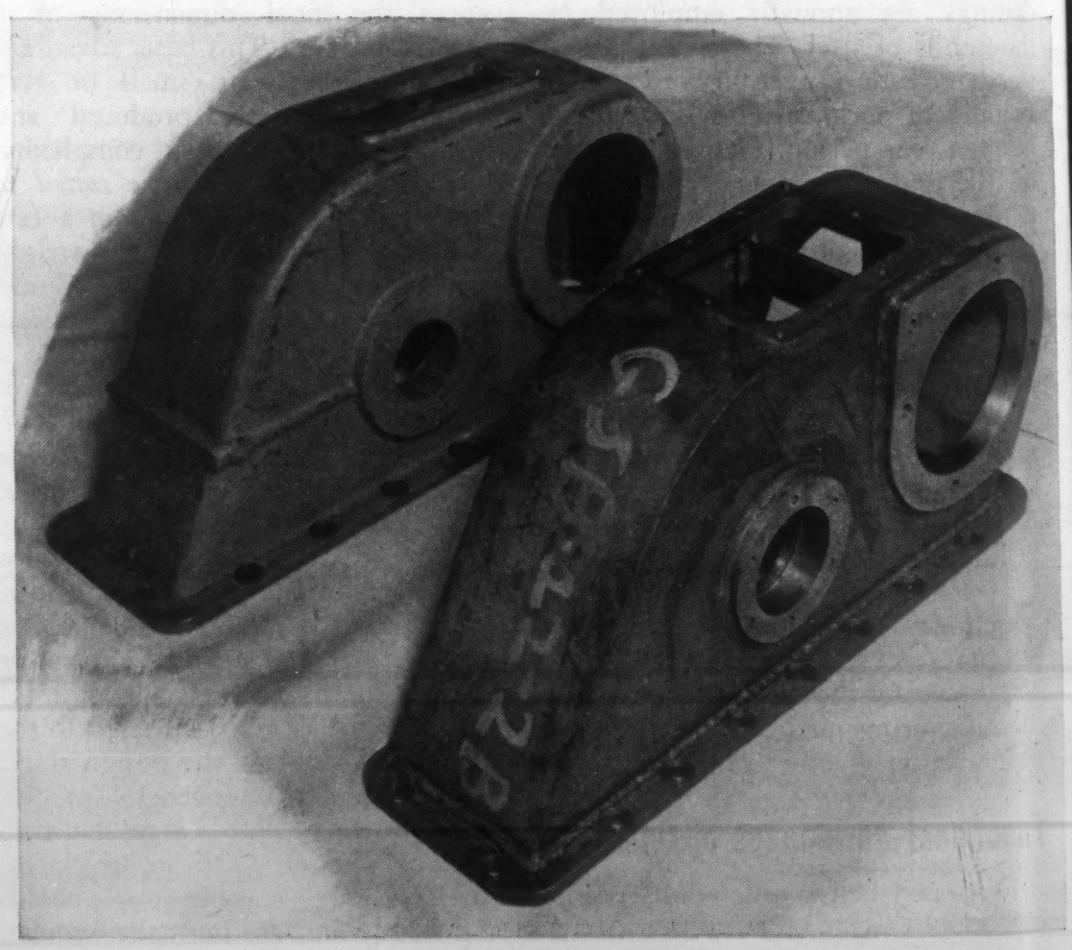
It is now recognized that if a part requires a specially designed or irregular surface for maximum operating efficiency, or possesses interior passages, or pockets, the possibility of casting the part as an integral unit should receive consideration over other construction methods.

From a quality viewpoint, a single integral casting is a safeguard against the possibility of costly assembly errors or mismating of parts. The latter is often cumulative when a number of pieces must dovetail together, and is an ever-present possibility in any complex cutting, forming or fitting operation. On the other hand, once dimensions for a one-piece casting are established as correct, exact duplication is automatic.

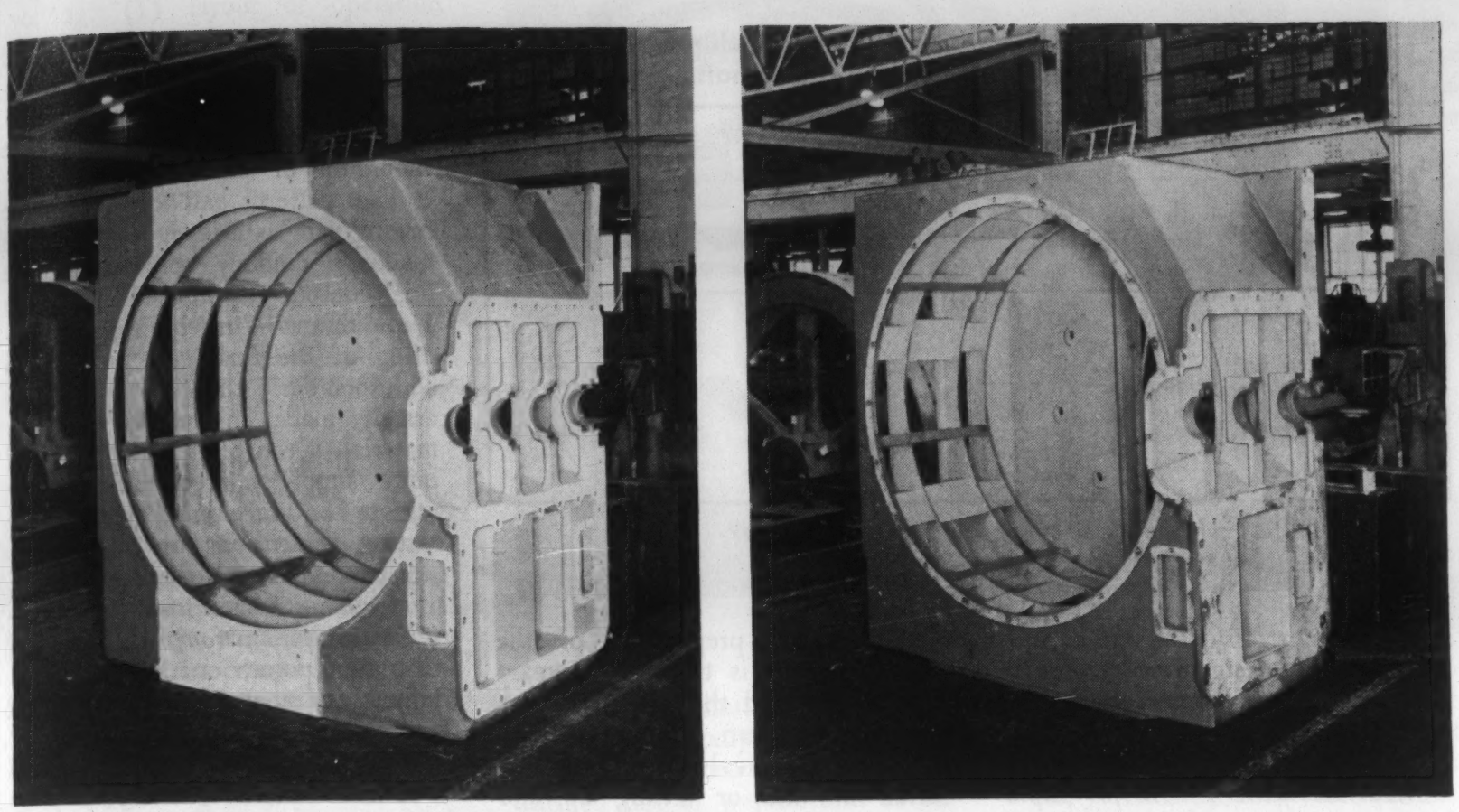
Dependability in service. Utilization of the known principles of good casting design, together with the periodic determination of the physical properties of test bars cast from the molten metal, assure a high degree of reproducibility and dependability in casting. When defects occur in gray iron castings, the defective casting can generally be detected and scrapped before being incorporated in a finished unit.

Economic Advantages

Economies of gray iron castings can be roughly divided into (1) those associated with the use of casting as a production method, and (2) those resulting from favorable characteristics of the particular metal used for casting. As far as possible, discussion in the present section will be limited to cost savings inherent in the use of the casting process itself. Considerations associated with the use of a particular metal will be cov-



Cast housing knee (left) eliminated the several individual parts needed for weldment (right).



Machining cost of welded blower housing (right) was 77% higher than that of casting (left).

ered in the next section.

Economies of production as a single unit. Because the casting process permits manufacture of a product as a single integral unit, substantial economies in assembly are made possible. Production of a single casting obviously eliminates costs of stocking, handling, cutting and machining to size a number of individual parts that would otherwise be necessary to produce the final product. Necessity for scheduling or routing parts so they will be simultaneously available at a given location for assembly is also eliminated.

Several accompanying illustrations indicate the simplification possible on replacing fabrication with a casting. In the case of a housing knee, use of the gray iron casting eliminated the series of individual parts needed in the comparable weldment. Consequent savings in torch cutting, machining, forming and welding operations resulted in a 50% lower production cost for the casting as compared to the welded assembly. In the case of a blower housing, the comparison of the casting and weldment is still more significant since its spidery character originally indicated a probable superiority for welding to the manufacturer. In a production test, however, the use of casting for this part eliminated assembling and handling 124 separate pieces. The machining cost of the welded assembly was 77% higher than that of the casting, resulting in a $222 balance in favor of its production as a casting.

Undue emphasis may be given to possible savings in metal weight using a given production method as opposed to casting. Certainly such weight advantages do exist, sometimes in favor of castings and sometimes in favor of other fabricating methods. More often, however, weight savings depend more on the use of the proper casting, welding or forging design for maximum economy than on altering the production method or base metal.

Individual circumstances known only to the producer finally control the choice of the manufacturing method. While the outlined economy of producing a part as an integral unit casting may be the deciding factor in a majority of cases, each case must obviously be considered separately before assuming that any one process will yield the maximum combination of functional efficiency and economy.

Savings in machining cost. Probably the most evident saving associated with casting is the ability to decrease machining cost. Instead of laboriously machining holes, interior passages and pockets required by the design, they are reproduced in the casting by placing sand cores of the correct dimensions in the original mold. Special surface contours are also incorporated in and made a part of the original pattern design. Obviously, savings vary with the complexity of the casting and the amount of machining that would otherwise be required. One division of General Motors has estimated an overall saving in machining cost of 50%. Table I includes typical savings in machining costs reported by other authorities.

Reduction in metal wastage. Metal savings, resulting from the ability in the casting process to place metal only where needed and to initially omit it by coring out where not needed, are obvious. It is not always recognized that this characteristic often permits a definite saving in the final as well as the rough weight of a component. For example, in diesel engine parts a careful comparison showed that the use of gray iron castings rather than weldments resulted in a saving of 14% in total weight as well as a 53% reduction in overall costs. Another producer reports drastic weight savings, approximately 50%, in cast as compared to forged crankshafts in the 500- to 5000-lb weight range because of ability to core out shafts, use hollow journals, and avoid superfluous weight. Confirmation from another authority is furnished by comparison of rough weights of forgings and castings in Table I. It is beginning to be realized that wider application of known stress analysis principles (use of wire

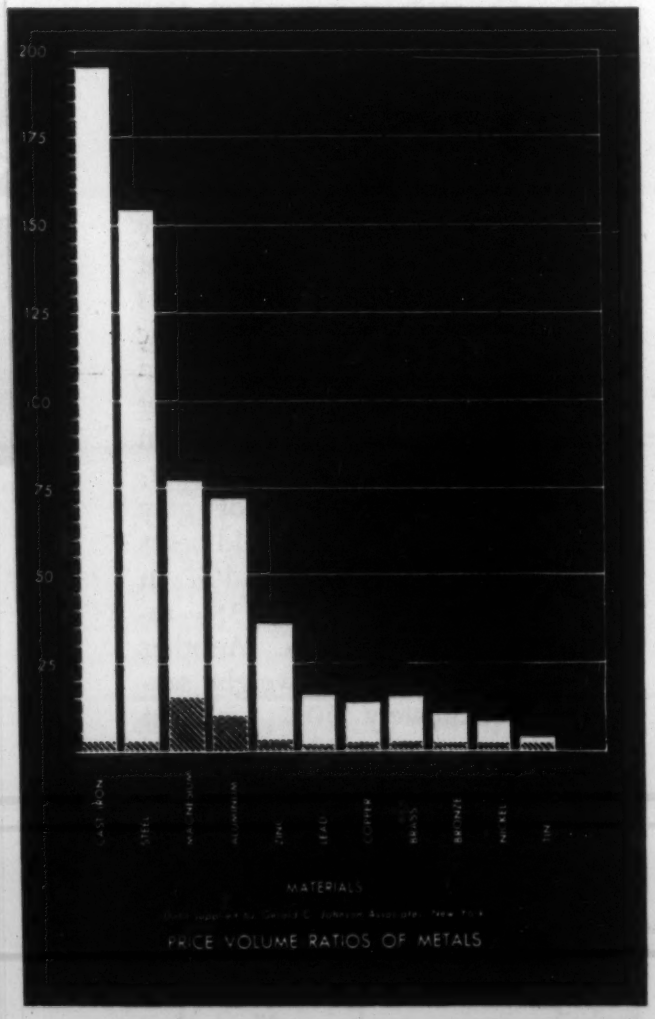
Table I—Comparison of Material Loss and Machining Time of Forged Steel and Gray Iron Crankshafts

Type of Engine Diesel	Steel Forgings			Gray Iron Castings			Savings	
	Lb Rough Weight	Lb Finish Weight	Hr Machine Time	Lb Rough Weight	Lb Finish Weight	Hr Machine Time	Lb Material	Hr Machining
6 cyl.	2,520	657	160	700	637	80	1,800	80
6 cyl.	1,344	287	100	256	216	30	1,017	70
4 cyl.	672	140	60	177	141	34	496	26
4 cyl.	924	279	73	300	278	55	623	18
6 cyl.	1,316	330	75	364	354	34	976	41
3 cyl.	469	133	73	120	96	24	312	49
4 cyl.	630	168	84	159	126	51	439	33

From "Automobile Engineer," April 1949

strain-gages, stress-coats, etc.), coupled with the design freedom inherent in casting, will result in further substantial savings in the weight of gray iron components.

Moderate pattern cost for rapid production. As noted, casting usually provides the shortest route from raw material to a finished product. This, in itself, by reducing the development cost chargeable to the product, can be a deciding factor in selection of the casting process. This development saving, as well as later production economies, is due to the fact that preparation of the master pattern is the only primary requirement and the major primary cost. This pattern cost is generally less than that involved in the preparation of dies or setting up and operating special tooling or welding arrangements necessary in other production methods.



Price volume ratio of common metals. Shaded areas show volume of 1 lb.

Pattern cost, however, in common with other capital charges, must be absorbed by the product. Obviously the greater the number of molds produced from a given pattern, the lower the pattern cost chargeable to each casting. Economic superiority for casting rather than individually welding a part can normally be demonstrated when a minimum of three to ten castings are made from a given pattern. The break-even point obviously varies with the size and complexity of the final casting.

It is always possible with sand molding to hold pattern cost to a minimum by selecting a pattern material of maximum machinability or formability, and of minimum cost for the number of parts to be cast from it, no such leeway being normally possible in constructing dies or jigs. For example, if only one or two experimental castings are needed, the pattern can be made of modeling clay, wax or plaster. In emergencies a simple mold cavity can even be formed without a pattern on the foundry floor. As the number of castings to be produced increase, more durable pattern materials are needed. These, in order of increasing durability, are pine, hardwood (usually mahogany), aluminum, steel and gray iron. Where a favorable combination exists of suitable casting shape and high production rate, patterns have, in special cases, been dispensed with and the desired casting cavity cut directly into a permanent (metal) mold that can be re-used to produce thousands of individual castings.

The pattern and cores for the casting can, as already described, be made to embody very exactly the final contour required and reduce to a minimum the machining and handling of the final cast product. In addition, since the pattern is deliberately made in readily workable material, it can often be directly and quite simply altered to meet last minute or developing changes in casting dimensions or product design unless these are very drastic.

Availability of castings and flexibility in production rate. From a cost standpoint, one of the most important features of castings, and in particular gray iron castings, are that they are normally available from a local source, minimizing delays in shipment and freight charges, and more important, facilitating full understanding of customer requirements. These economic advantages are obviously at a maximum when a close working relationship is maintained between the customer's designers or engineers and the foundry.

The casting process itself is immediately responsive to variations in product demand. Emergencies or varying market conditions involving increased or decreased production can be immediately met at minimum cost since a pattern corresponding to the part required needs simply to be stored by the foundry or manufacturer. All other facilities, such as mold flasks and molding machines, constitute part of the standard operating equipment of the usual foundry and are used interchangeably with a large number of patterns for many different jobs.

Savings in indirect or overhead costs. It has only recently been recognized that employment of a single integral casting will drastically reduce indirect costs. These indirect costs, as well as the usual direct material labor charges, must be borne by a product. The most notable economies are effected by castings where use of a number of individual parts instead of a single casting directly multiply indirect charges. The most obvious savings, following the use of a single casting instead of a component made up of a number of assembled or welded parts, are elimination of costs in-

volving: (1) layout of operation sheets outlining the necessary operations on individual parts, (2) setting up production standards for individual parts of the final assembly based on time studies, etc., (3) production control by which movement of a number of individual pieces is controlled to facilitate final assembly, and (4) inspection operations, which naturally increase or decrease with the number of individual components entering into the final product.

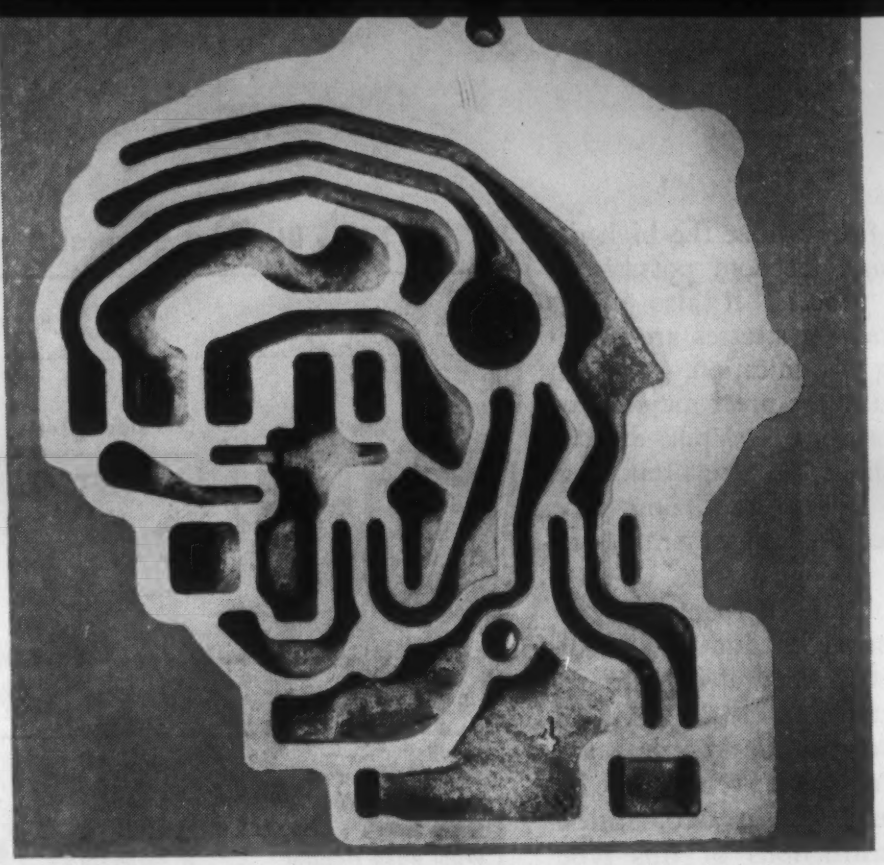
Gray Iron vs Other Cast Metals

Each of the metallic material commonly used in casting—namely gray iron, malleable iron, steel, copper-base, aluminum-base and special alloys—has its own legitimate place in the industrial economy. The purpose of the present section is to very generally discuss the specific advantages of gray iron as a construction and engineering material within its own sphere of usefulness.

Low unit cost. There is no question that the low price of gray iron as compared to other cast metals has contributed to its wide use in industry. Economy is realized due both to savings inherent in the casting process as described in the preceding section and to favorable factors uniquely associated with gray iron itself. For example, gray iron is essentially a low cost raw material as compared to other metals used in industry. This has been expressed in the form of charts, such as shown in the accompanying one. This chart was plotted in 1948, but the comparative volume ratios have remained essentially constant over later price cycles. The low raw material cost of a ferrous metal is, of course, only a small part of the final cost of a ferrous casting, and despite the chart, is probably about the same for both gray iron and steel. The high basis price of non-ferrous metals, however, is a major handicap in attempts to substitute them for gray iron or steel castings.

The economic position of gray iron is enhanced in comparison with other ferrous castings because it can be melted in the highly efficient cupola furnace. Of even greater significance, as will be described more fully, gray iron possesses better casting qualities than other ferrous metals.

Accurate comparative cost figures using two methods of construction as widely different as casting and welding are admittedly difficult to compute. The only realistic method is to compute the final cost of the finished cast or welded unit as machined, handled, assembled, heat-treated if necessary, and ready for use. Both direct and indirect charges, and usually a design or development charge, must be included. Actual comparative costs of a cast as opposed to a similar welded component, where principles of parallel charges are observed, are contained in Tables II and III. It should be stressed that most of these tests were made in shops where welding and casting facilities were both equally available. The actual dollar figures in columns 4 and 5 of Table II are only comparative since they were determined some years ago. The ratios are sound, however, since the noted higher cost of weldments depended mainly upon greater labor costs, and labor rates have risen in recent years more rapidly than material costs.



Cast valve section o automobile hydrauli control shows fin casting characteristic of gray iron.

High fluidity, low shrinkage and maximum design freedom. Of ferrous-base castings, gray iron has the highest fluidity or life and is, therefore, particularly adapted to production of intricate and comparatively thin-walled castings. Because it is a ferrous metal, gray iron tends to free itself of entrained gases and inclusions much more rapidly than light metals, such as aluminum and magnesium. Probably most important from a design viewpoint is its low solidification shrinkage, which, depending on composition, varies from 0 to 1.9% while the comparable shrinkage for steel or malleable iron is about 5.0%. The contraction of gray iron after solidification down to room temperature is also about one-half that of most other cast metals.

These two factors—high fluidity and low shrinkage—means that it is much simpler and economical to obtain sound castings of intricate shapes and to hold close tolerances when gray iron is employed. In other words, gray iron allows the

Table II—Comparative Weight and Cost—Castings vs Weldments

Material	Weight Gray Iron Casting, Lb	Weight Weldment, Lb	Cost Casting, $	Cost Weldment, $
1000-Hp Diesel Block and Base	10,620	11,442	$1,774.39	$6,874.89
600-Hp Diesel Block and Base	3,375	3,340	1,203.56	3,579.41
Diesel Exhaust Manifolds	422	222	180.00	345.00
Aux. Drive Housing	738	361	200.00	385.00
600 Hp Chain Drive Housing	287	295	200.00	460.00
1000-Hp Chain Drive Housing Knee	122	121	70.00	125.00
600-Hp Chain Drive Housing Knee	49	45	10.00	45.00
1000-Hp Turning Gear Housing	104	110	100.00	290.00
600-Hp Housing Cover	42	46	15.00	62.00

From "Iron Age," May 18, 1944

engineer to fully utilize the high degree of design freedom possible in the casting process. It also means that lower casting stresses are developed during solidification, so much so, in fact, that the great majority of gray iron castings are put directly into use without the stress-relieving, normalizing or malleabilizing heat treatments required by other ferrous metals.

An example of the many intricate cast components in industry made possible by the fine casting characteristics of gray iron is the gray iron hydraulic control housing and the valve body or nerve center of the "power glide" used in automobiles. Involved constructions of this type are only economically feasible as integral castings. The valve body was experimentally cast in aluminum. Gray iron was, however, the final choice. More important than its lower cost was the fact that; (1) gray iron was more rigid, strong and dimensionally stable, (2) could be held to closer tolerances, (3) possessed much greater wear resistance as a valve seat and to valve stems, (4) did not tend to imbed dirt as did softer nonferrous materials, and (5) possessed thermal expansion characteristics more closely matching other parts of the fluid drive system.

Table III—Cost Comparison: Cast vs Welded Classifier[1] Parts

Description	Welded Steel	High Strength Gray Iron[2]	Weight, Lb
"DSFX" Classifier			
Bell Crank	$51.00	$35.96	185
Connecting Rod	57.50	43.50	250
Eccentric Hub	60.00	42.15	117
Front Link	21.13	16.43	85
Front Link Support	36.70	35.70	170
Rear Link	23.66	16.78	90
"DSF" Classifier			
Bell Crank	$43.89	$32.18	144
Connecting Rod	49.44	34.30	150
Front Link	15.00	10.57	40
Front Rake Hanger	18.09	11.61	50
Front Link Support	26.44	24.94	100
Lifting Lever	30.10	22.58	125
Rear Link	17.26	13.26	54
Rear Rake Hanger	17.49	11.55	50
"FH" Classifier			
Bell Crank	$29.89	$15.75	71
Connecting Rod	36.47	23.92	98
Front Link	14.03	9.05	35
Front Link Support	16.95	13.21	55
Rake Hanger	14.80	8.01	30
Rear Link	14.16	9.78	25

[1] *Standard Dorr classifiers used for ore concentration.*
[2] *A 50,000-psi gray iron designated "GA" Meehanite used in these comparisons.*

From "Iron Age," Sept. 14, 1950

Wide choice of physical properties in as-cast condition. Gray iron offers the widest choice of strength and hardness in the as-cast condition of any existing metal. For example, it is possible by analysis control to produce gray irons that range from a soft type with the optimum machinability characteristics of any known ferrous material, to a harder, higher strength type approximating or exceeding the strength of many cast steels. However, alloying is generally essential if strengths of over 50,000 psi are required.

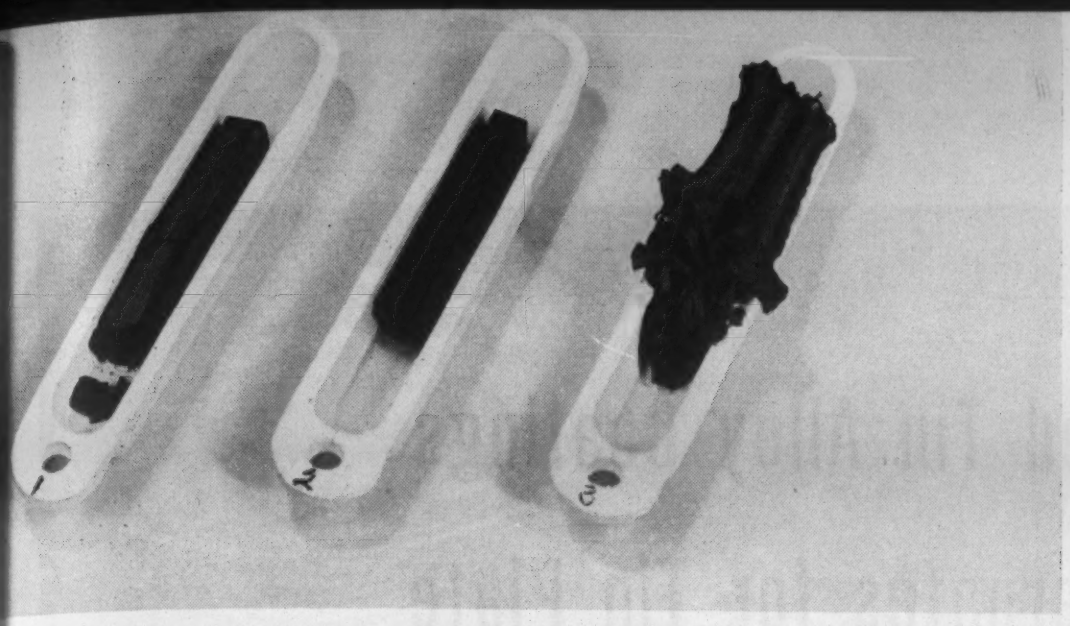
In severely abrasive applications, it is of particular interest that by very rapidly cooling gray iron with chillers during solidification, it is easily possible to develop as cast an extremely hard, white-iron surface or surfaces at any selected location on the casting. These white-iron areas possess outstanding abrasion resistant properties. The rest of the casting remains soft and maintains its favorable machinability characteristics.

Unique properties available in gray iron. In addition to the factors listed above, the average gray iron as already noted is one of the most readily machinable metals. This is, at least, partly due to its contained graphite facilitating ready breaking up of chips formed on machining with consequent greatly reduced tool wear. As established recently, a gray iron casting, as opposed to other cast metals, can often be roughed and finished in a single cut.

Other valuable properties that gray iron is known to possess in a much greater degree than other cast or fabricated ferrous metals are: (1) vibration absorption, (2) self-lubricating properties and ability to retain a surface oil film under adverse conditions (with consequent high resistance to wear and seizure), (3) low notch sensitivity, (4) compressive strength approximately three times as great as the tensile strength, (5) a response to heat treatment comparable to that of eutectoid steel, (6) comparatively high corrosion resistance to tap water and other mildly corrosive media, and (7) a controllable modulus of elasticity that minimizes distortion on heating. As in the case of other ferrous metals, strength, wear resistance and corrosion resistance can all be enhanced by proper alloying.

The dimensional stability possessed by gray iron has already been noted, and this is coupled with an ability to distribute stress, *i.e.*, avoid stress concentration. This property has been described by designers as the "cushioning effect" of gray iron in comparing gray iron camshafts with steel camshafts. This and many of the other unique properties of gray iron depend on the presence of uniformly distributed graphite flakes in the structure, which, in turn, limit the plastic deformation that can be undergone before failure. There are very few industrial applications where permanent deformation can be utilized or even tolerated. However, when such cases exist, the use of other metals or newly developed nodular graphite gray iron should be investigated.

This article is based on a chapter to appear in the forthcoming "Gray Iron Handbook". The complete chapter has been printed as a separate manual and may be purchased from the Gray Iron Founders' Society, Inc., 210 National City—East 6th Bldg., Cleveland 14, Ohio.



Samples (left to right) of 18:8 stainless steel, chromium carbide and tungsten carbide after exposed to 1850 F for 24 hr.

New Chromium Carbides Have High Temperature and High Corrosion Resistance

NEW MATERIALS PREVIEW

● A NEW MEMBER of the group of cemented carbide materials—chromium carbide—was announced recently by the Carboloy Dept. of General Electric Co. Chromium carbide is being produced in a series of compositions called Series 600 by the company, and is now available in limited quantity. Expansion of production facilities has already begun.

Some of the important features of the chromium carbide series are:

1. Excellent corrosion resistance.
2. Good resistance to deterioration at high temperatures.
3. Good abrasion and erosion resistance.
4. Relatively light weight.
5. Nonmagnetic.
6. Materials used are less critical in supply than most of those required for cemented carbides.

Corrosion tests made upon chromium carbides by the manufacturer and at Battelle Memorial Institute indicate excellent resistance to corrosion by a number of agents. In the salt-spray test, samples were held in a 30% salt mist for 750 hr. At the end of that time the samples retained their metallic luster and showed no other evidence of corrosion. Tests made with the strong mineral acids, including sulfuric acid and nitric acid, gave the chromium carbide about 30 times the resistance of 18:8 stainless steel, and about three times the resistance of the standard carbide materials when sulfuric acid was used, and about twice that of the stainless steels and eight times that of other carbides when the nitric acid was the corrosive agent.

The new carbides are reported to be practically inert under all test conditions involving the weak organic acids, including citric and lactic acids. As these acids are among the most common in food fermentation, the materials should have possibilities in the food processing equipment field.

Resistance to oxidation at high temperatures is so good that such uses promise to be among the most important for the new carbides. One of the disadvantages is its rather high rate of oxidation at red heat. Titanium carbide is much more resistant. Chromium carbide seems to be almost completely resistant to oxidation at all temperatures up to about 2000 F. Samples exposed to a temperature of 1850 F for 24 hr retained their luster, while tungsten carbide samples in the same test completely disintegrated.

Hardness appears to be about the same as that of tungsten carbide materials at room temperatures, and is approximately 80 to 93 Rockwell on the A scale. Wear resistance is good in the applications so far made. Gage blocks, plug and ring gages, surface plates, and similar pieces made of the new carbide have shown good resistance to abrasion and high corrosion resistance. An important feature of its adaption to gages is the fact that the carbide has about the same coefficient of thermal expansion as steels, so that results are not affected by air temperature variations when working with steel.

Chromium carbide is lighter in weight than tungsten carbide, and this reduces pounding when used as balls in check valves in the petroleum industry. This, with its high resistance to abrasion and erosion, is translated into longer life. The same properties seem to give it longer life when used in centrifuge blades, while resistance to steam erosion was indicated as being about 50 times that of the conventional carbides.

An important feature of the new series of chromium carbides is that the materials are less critical in supply than tungsten or cobalt, the bases for most of the cemented carbides. Chromium carbides are made with a carbide powder of about 70% chromium, and nickel is used as the matrix material.

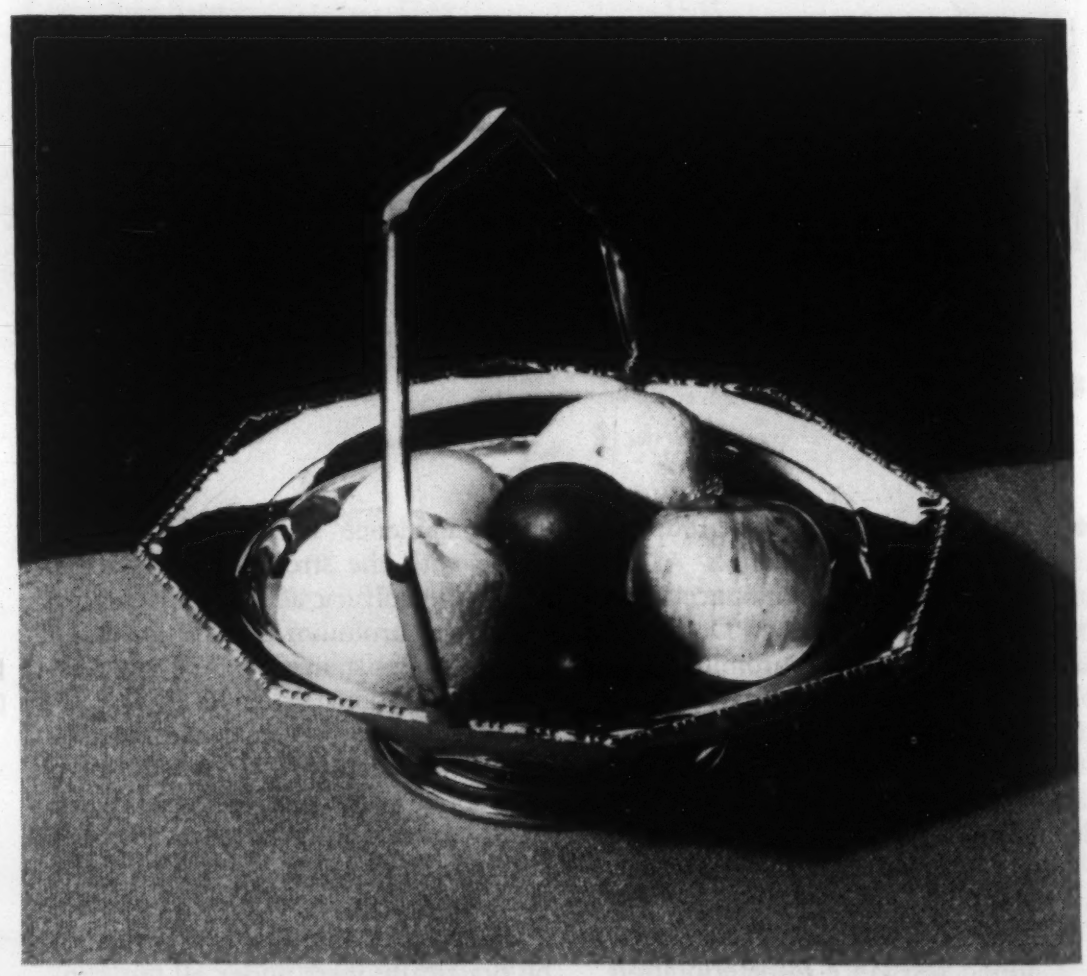
The new carbides appear to be stable when formed, and internal stresses have not appeared in pieces made with them. Forming methods are the same as for other carbides. There appears to be no physical limitation upon the size and shape of the piece when the proper equipment is available. The workpiece has sufficient toughness to withstand grinding without chipping at the edges, and brazing and mechanical attachment can be accomplished in the tipping of tools in the same manner as with the other carbides. It can also be fastened by means of adhesives of the thermosetting plastics types where such bonding is indicated.

Applications of the material have been on an experimental or test basis to date, as production is still limited. Gages of many types, check valves, and a few similar items have been made and field-tested. It is expected that future uses will include high-temperature applications, uses in the chemical industry, and the like.

Electrodeposited Tin Alloy Coatings Are Promising Alternates for Tin Plate

by **KENNETH ROSE**, Western Editor, Materials & Methods

New tin-copper, tin-zinc and tin-nickel plates can be used on most common metals and have many potential applications in both the industrial and decorative fields.



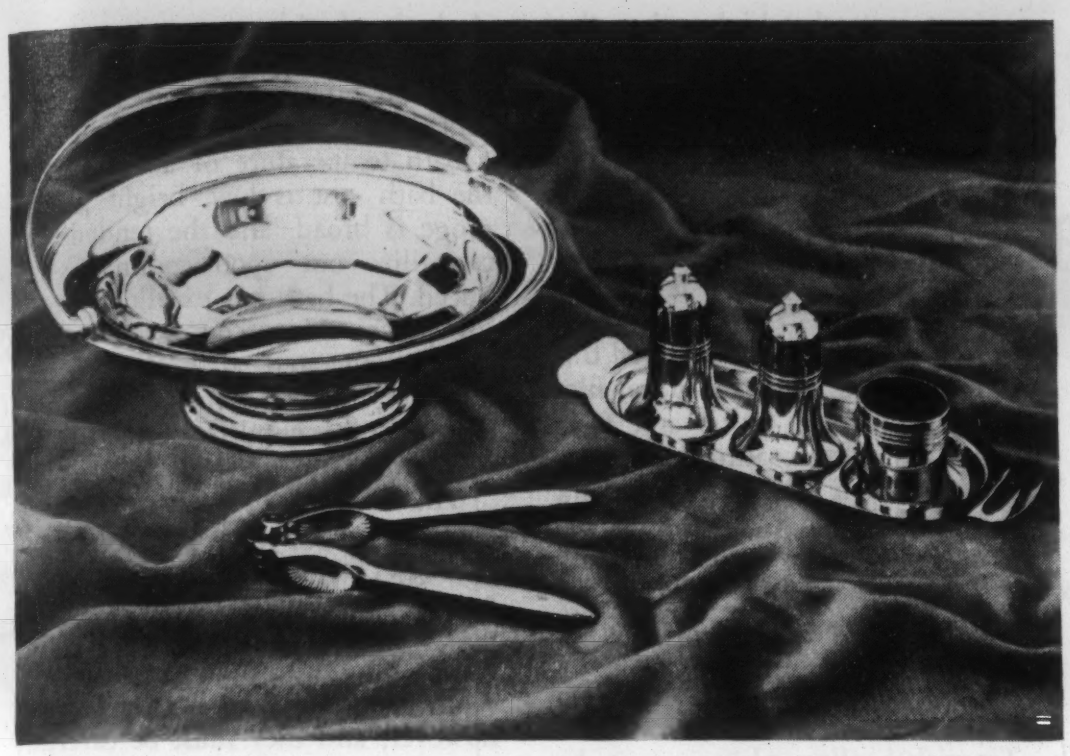
Speculum plating give deposits that have the brightness of silver. (Tin Research Institute)

● RECENTLY ATTENTION has been drawn to several electrodeposited alloys containing tin, partly because of the inherent qualities of the alloys, and partly because they hold out the promise of providing alternates for other metals now in short supply, or for which future shortages are predicted. A series of these alloy plates is receiving attention from engineers for many kinds of applications, both for appearance and for difficult service.

Tin itself is still under government control. The actual supply of tin, however, is larger than current demand, and there is little foreseeable danger of a tin shortage. During the war years, when the Malayan, Burma and Indonesian tin-producing areas were in enemy hands, tin was in extremely short supply, and every means of conservation of the metal, and recovery for reuse, was practiced. Rehabilitation of all these areas has been effected, and there is little likelihood of a repetition of the wartime supply situation. In America, the Texas smelter produces from one-third to one-half our needs from Bolivian ore, and the recovery of tin from can stock clippings (although small) produces an additional amount. Although the price of tin advanced sharply under the spur of government stockpiling, the increase in price was much less than the price increases in many other metals. The present price ($1.03 per lb) is now about where it was in O.P.A. days, following some price gyrations as a result of the Korean War. The future price and control picture for tin is not quite clear, but it seems likely that the supply will be adequate.

Tin-Copper

Several years ago there was a flurry of interest among American electroplaters in a new alloy coating for decorative metal work. The plate was an alloy deposit that had the brightness of silver, closely resembled silver in color, but was highly resistant to tarnishing. It was called speculum plate, and the deposit was composed of 45 tin and 55% copper. Its obvious advantages seemed to promise it a wide field of applica-



Some typical items with a decorative tin-nickel alloy plate. (Tin Research Institute)

tion, but the fact that the deposit required buffing to develop a full luster, coupled with wartime restrictions on tin, caused prospective users to lose interest.

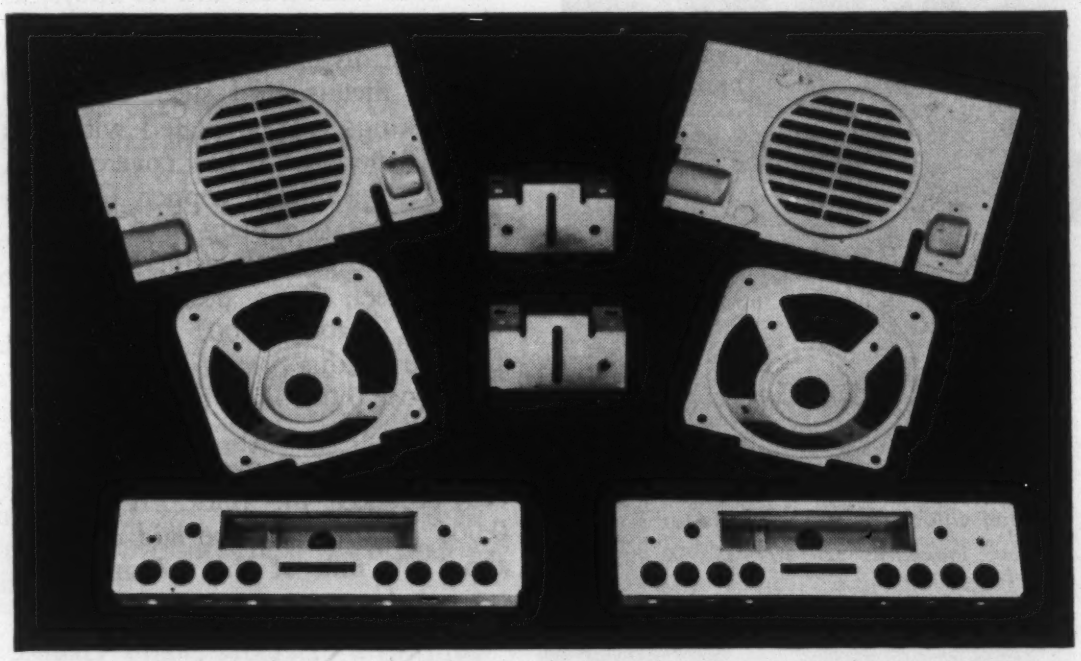
A new speculum plating bath which gives bright deposits has been developed by Battelle Memorial Institute for the City Auto Stamping Co., Toledo, Ohio, who hold the patent rights to the process. The commercial development of the bright speculum process has been undertaken by the R. O. Hull Co., Rocky River, Ohio, and technical service is available from that source.

Tin-Zinc

One of the newer alloy plates is the tin-zinc deposit, composed of about 80 tin and 20% zinc. In addition to possessing good corrosion resistance and good solderability, the alloy plate has the desirable feature of being easily deposited and the operation easily controlled. The deposit is clean and attractive in appearance, but is not bright and lustrous as deposited.

Tin-zinc electrocoats have been used extensively in England during the past few years. They have been considered as industrial coatings rather than as decorative plates for consumer items. The field for which tin-zinc alloy plates seem to have special qualifications is in the plating of radio and television parts for corrosion resistance, and as a replacement for cadmium deposits generally. Cadmium is generally considered to be somewhat superior to zinc as a corrosion resisting electroplate in the tropics and for marine use, but it is more difficult to solder, especially after exposure to the air for about six months. Strong fluxes must be used to produce a secure bond. It is in this matter of solderability that the alloy plate has a definite advantage, as it can be soldered easily and with noncorrosive fluxes. It is, of course, much superior to zinc films in the matter of solderability. In retention of solderability after use of storage, it is even somewhat better than pure tin, according to reports.

The suitability of the alloy plate as a replacement for cadmium becomes of increasing importance as cadmium becomes scarce, or as the price increases. At present, the metal cost of the alloy plate is a little over half that of cadmium.



A group of radio components plated with a tin-zinc coating. (Tin Research Institute)

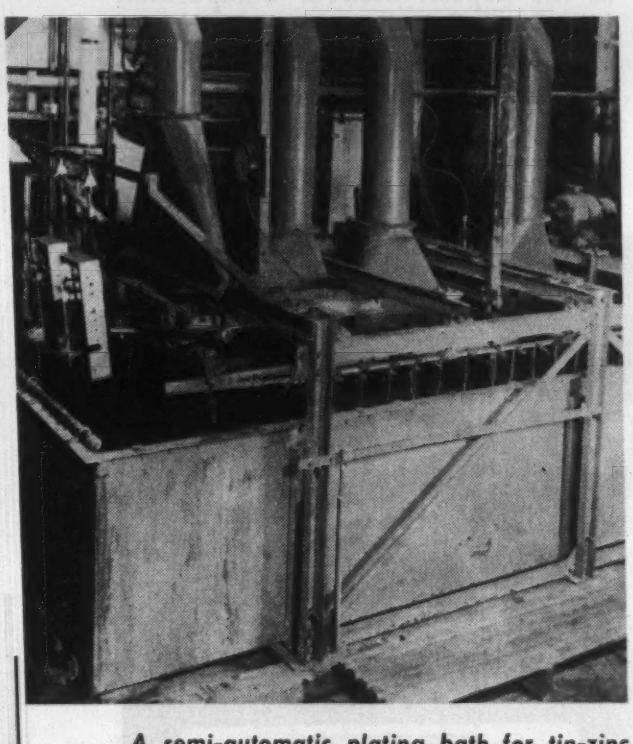
The plate can be laid down over most base metals, including steel, brass and copper. It produces an attractive deposit on malleable iron. The electric and electronic industries have been among the early users. A plate thickness of about 0.0003 in. is commonly used, and this can be laid down in about 9 min with a current density of about 30 amp per sq ft. Increasing the current density, within the limits suggested, will speed the deposition, but cathode efficiency will fall off somewhat.

The alloy is plated from an alkaline cyanide solution. The anode used is an alloy of the same composition as the deposit desired. Composition is not too critical, as the properties of the alloys in that range vary gradually. While 80-20 tin-zinc is the most generally useful proportion, variation of about 5% either way will not cause important change in properties. Greater variation will cause a lowering of properties; increase of zinc permits formation of white corrosion products when exposed to salt spray, and increase of tin also lessens corrosion resistance.

Two formulations are recommended for the bath by Metal and Thermit Corp., which has studied British practice in these electrocoatings. One is intended for still tanks, the other for tumbling barrels. The compositions of the baths are given in the accompanying table. The solutions are made up by running about two-thirds of the water into the tank, heating to the working temperature of 150 F, adding and dissolving the potassium hydroxide, then the potassium cyanide, next the zinc cyanide,

and finally the potassium stannate. The remainder of the water is then added, the analysis of the bath checked, and it is ready to operate.

The Tin Research Institute adds a warning about the bath composition. Sodium stannate made from tinplate clippings will contain a small amount of organic matter, which suppresses the deposition of zinc. In order to obtain the desired composition in the deposit, the amount of zinc and alkali hydroxide in the bath must be increased. Increasing the cyanide content by up to 50%, and the alkali hydroxide by up to 15%, is the recommended procedure.



A semi-automatic plating bath for tin-zinc plating industrial products. (E. M. I. Factories Ltd.)

The British work was done with sodium salts in the plating baths, but use of potassium compounds permits higher current densities to be employed, speeding the plating by two or three times. With potassium compounds the current density at the cathode can be between 10 to 75 amp per sq ft, and anode density about 15 to 25 amp per sq ft. The differential current density will be held to proper ratio if the anode area exceeds work area in the proportion of about 1.5 to 1 or 2 to 1. The anodes must be filmed, and running a current somewhat higher than that for normal operation will produce a film over the anode in a short time, usually less than a minute. New solutions usually function better after a few hours of operation. The bath has excellent throwing power.

Tin-Nickel

Another alloy plate introduced this year in England is the tin-nickel film consisting of about 65 tin and 35% nickel. This electrocoating has exceptional corrosion resistance, a faint pinkish color, and can be produced with a high luster. It has been suggested in England as a possible rival of chromium plate. Auto accessories, tableware, fittings, ash trays, cigarette lighters, etc., have been plated with the alloy.

Tin-nickel alloy plate cannot be deposited directly onto zinc alloys, nor onto aluminum and its alloys, as these metals are rapidly attacked by the electrolyte. It coats other nonferrous metals, and steel. Zinc-base die castings can be plated with this alloy if the work is first covered with a protective film of copper. On nonferrous metals a plate of 0.0003 in. is adequate for all ordinary service. With steel, it is desirable to lay down a coating 0.001 in. thick to provide lasting protection. A copper undercoat 0.0005 in. thick is recommended with steel, and the alloy plate laid down over this need be only 0.0005 in. thick. A deposit 0.001 in. thick will be laid down in about 30 min at the recommended current density.

The plate has excellent corrosion resistance in both indoor and outdoor service. Its attractive color and bright appearance seem to indicate a broad field of usefulness for decorative purposes.

The bath is a chloride-fluoride preparation, and the method uses separate anodes. Composition of the bath is as follows:

	Oz per Gal
Stannous chloride	6.7
Sodium fluoride	3.75
Ammonium hydrogen fluoride	4.7
Nickel chloride	40.0

A bath of this composition seems to be the best compromise between cost and high production. At a current density of 24 amp per sq ft and a bath temperature of about 150 F, the bath cost is low, bright plating range is broad, and the tendency to crystallize out upon cooling is reduced. The bath has excellent throwing power. More concentrated baths can be operated at higher current densities, but are considerably more costly, and crystallize rather easily when the bath cools.

The tendency of the tin anodes to sludge is reduced by encasing them in bags. Tin anodes must be raised out of the bath when not in use. The nickel anodes cause no trouble. Any organic impurities in the bath will cause serious pitting of the deposit, however, and they must be carefully excluded. Organic wetting agents must not be used in the bath. For best brightness the solution should be continuously filtered, and the cathode should be oscillated slightly. As the bath continues in service the brightness of the plate tends to fall off. It is restored by additions of hydrofluoric acid and/or fluorides.

The fluoride vapors given off by the solution when the bath is operating are poisonous, and an exhaust system must be provided. Tanks should be rubber-lined, and the rubber should have as little sulfur and filler in its composition as possible.

In addition to the true alloy plates, tin has made a place for itself as a secondary or supplementary plate in several applications. Aircraft engine cylinders are frequently chromium plated, and the piston rings that ride against them are sometimes chromium plated also. Chromium plating is poor seating material, and chromium plating working against other chromium plating develops poor friction qualities. The two surfaces are said to be "incompatible." If a plate of tin is deposited over the chromium on the rings, "bedding" is improved, and the frictional qualities are satisfactory. Chromium plate working over tinplate is a good combination from a frictional standpoint. Life between engine overhauls is greatly lengthened by this method.

Solutions for Tin-Zinc Alloy Plating

Still Tank Solution, Oz per Gal			Tumbling Barrel Solution, Oz per Gal		
Potassium stannate	16.0	(equivalent to 6.0 of metallic tin)	Potassium stannate	12.7	(equivalent to 4.7 of metallic tin)
Zinc cyanide	1.2	(equivalent to 0.67 of metallic zinc)	Zinc cyanide	1.8	(equivalent to 1.0 of metallic zinc)
Potassium cyanide	2.8		Potassium cyanide	2.0	
Potassium hydroxide	0.87		Potassium hydroxide	1.3	

High Quality Nonferrous Castings Assured by Use of Radiography

Adoption of x-ray inspection reduced machining time, cut material costs, and improved the quality of valve castings.

by **CHARLES B. JOHNSON,** Chief Engineer, Rockwell Manufacturing Co.
and **STANLEY A. BROSKY,** Department Head of Metals, Pittsburgh Testing Laboratory

● RADIOGRAPHIC INSPECTION is a valuable aid in obtaining high quality, sound castings. This fact was clearly demonstrated when, several years ago, Rockwell Manufacturing Co. successfully resorted to radiography to guarantee sound, pressure-tight nonferrous castings required for their Nordstrom Valve.

At that time the percentage of rejects in castings from the suppliers was abnormally high, and at times this percentage reached 100% for individual shipments. Castings that were apparently sound were found faulty when subjected to final tests. Conventional hydraulic tests and visual inspection by the supplying foundries were not sufficient because the finished product is sometimes used on gases or violently active chemicals that penetrate the metal through fine pores not detectable by these test methods. In addition, the nature of the product was such that leakage was encountered only after machining through surfaces of which one side had been machined and the so-called protective skin removed. A rejection at the final test resulted in the loss of machine-hours. This was very costly, as was the loss of material, assembly and dis-assembly labor.

In order to alleviate these conditions and supply satisfactory castings to the manufacturing section, arrangements were made to work directly with a captive foundry. The raw materials and the charging of the furnace were carried out under close supervision. Temperatures, both melting and pouring, were closely controlled. Various heats were purged, using different purging agents. Melts were made of both virgin metal and secondary ingot. A detailed log was made of every heat. This included chemical analysis of both raw materials and finished products, test bars, to determine physical properties, temperatures, both furnace and pouring, and the type of raw materials used. Under these conditions the yield of usable castings was increased, but not to the point where all castings could be machined with the assurance that they would be pressure-tight when finally assembled.

It was also found that by using secondary ingot, satisfactory castings could be produced. Experience showed that the use of virgin materials increased our yield to some extent. It thus became evident that some method of non-destructive, pre-machining inspection was necessary.

Several methods were investigated, and the x-ray method was finally accepted as offering the most promise. In an effort to provide a method or technique which would be infallible, many castings were examined by x-ray and then cut up into wafers or slices, varying in thicknesses from

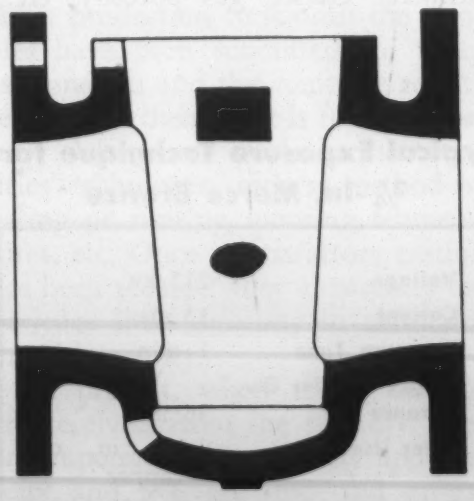


Fig 1—Cross-section of a typical valve body. Black circle in center indicates where radiograph was taken.

Fig 2—Positioning x-ray machine prior to radiographing the casting.

1/16 to ½ in. X-rays were made of the individual slices and also of the slices after they had been re-assembled in order to determine just what could be expected from the x-ray when used on castings of varying thicknesses. Many castings were machined, assembled and tested to substantiate the x-ray findings.

It was discovered early in the investigation that x-raying the entire casting would prove too costly. The critical areas for each type of casting were located by machining, testing and re-x-raying. Fig 1 shows a cross-section of a typical valve body with the black areas indicating the critical areas and the circle in the center showing where the x-ray radiograph is taken.

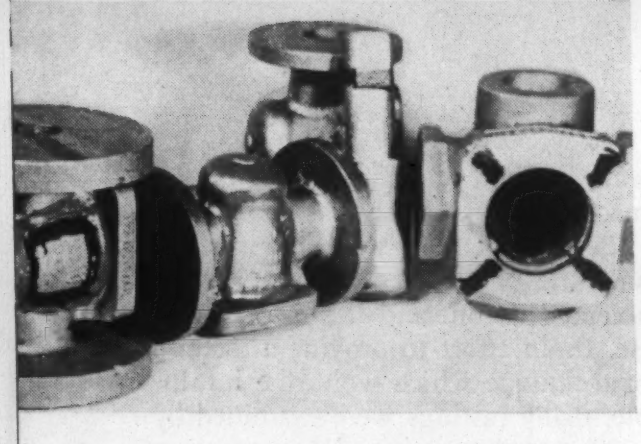


Fig 3—Group of castings after being classified.

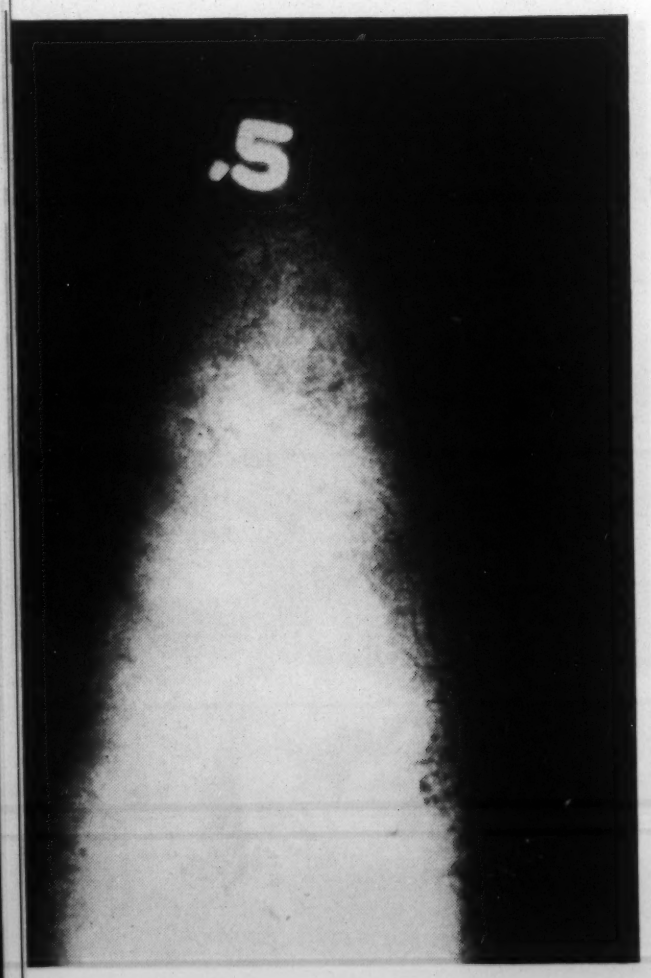


Fig 4—Radiograph showing fine mottled structure, indicative of "dross-like" porosity, and fine cracks.

At first the results obtained were not entirely satisfactory because the obvious defects were not the ones that were causing the so-called leakage. As mentioned before, the castings that leaked after final machining showed no flaws or defects upon visual examination of the machined surface. When x-rays were taken of relatively small spots using the proper exposure, it was found that the type of porosity which was causing the trouble had been overlooked. This porosity we have called microscopic.

Particular care was taken to work out the best technique for revealing this peculiar structure in various metals. The technique for Merco Bronze is given in the table. It should be pointed out that all of the work using this technique is done with Kodak Type K film since it is very fast and the grain structure or size makes interpretation of radiographs of rough castings easier. It was found that the coarseness of the film grain helped eliminate the surface roughness of the casting on the radiograph.

In most instances a single radiograph of as little as 4 sq in. of area will provide sufficient information to accept or reject the castings in sizes up to and including 4 in. Such a casting will weigh approximately 60 lb. Above this size one critical spot in the body of the casting and one such spot in the connecting flange area is x-rayed. This technique has proved satisfactory for use on castings weighing up to 4,000 lb.

Radiograph Interpretation

Interpretation of the radiographs is somewhat different than that usually practiced with routine radiographs. Obvious defects, such as blow holes, shrinkage cracks, gas porosity, etc., are secondary in the acceptance or rejection of the casting. The first item of major importance is whether or not the metal quality is satisfactory. If the quality of the metal is acceptable, then the obvious defects play their part in determining the acceptance or rejection of the casting. Naturally, the size of the defects, their location and their dispersal also have a great bearing on this acceptance or rejection.

Interpretation of the negative must of necessity also include the visual examination of the condition of the surface of the casting at the same time the radiograph is viewed on the view box. For example, castings that are very smooth as far as outside appearance is concerned can be very porous when internal structure is considered. Furthermore, castings that show an extremely rough surface condition have been found in many instances to be sound and of good metal quality.

In general, the interpretation of the radiographs is based on the ability of the radiographer to see the the fine mottled structure, at times interspersed with pin-pointed dark areas which we have to call "dross-like" porosity. This term "dross-like" porosity was selected to describe a condition that exists in the non-acceptable castings and appears to be caused by a material similar to dross that has moved through or has been entrapped in the casting. In the past, this condition has been referred to as microshrinkage or micro-porosity. It has been found that castings showing this condition to a minor extent have been "leakers" under pressure testing, and, of course, are rejects after machining.

In order to check the accuracy of the x-ray examination, the castings were pressure tested. All castings were checked at double the rated working pressure. Based on the results of this checking, a 3-way classification of castings as received from the foundries was set up. These three classifications were (1) acceptable, (2) borderline acceptable, and (3) not acceptable. Acceptable castings were those of which there was no doubt as to their being satisfactory after machining and assembly. Borderline acceptable castings were those in which there was better than a 50% chance that the castings would prove pressure-tight after machining. These do not include such defects as cracks, large blow holes or other similar defects for which castings are normally rejected. The not acceptable castings included those in which the

Typical Exposure Technique for ¾-In. Merco Bronze

Voltage	215 kv
Current	15 ma
Exposure Time	1 min
Target to Film Distance	36 in.
Filter Used	0.015 in. of copper
Penetrameter	2% of thickness
Type of Film	Kodak Type K

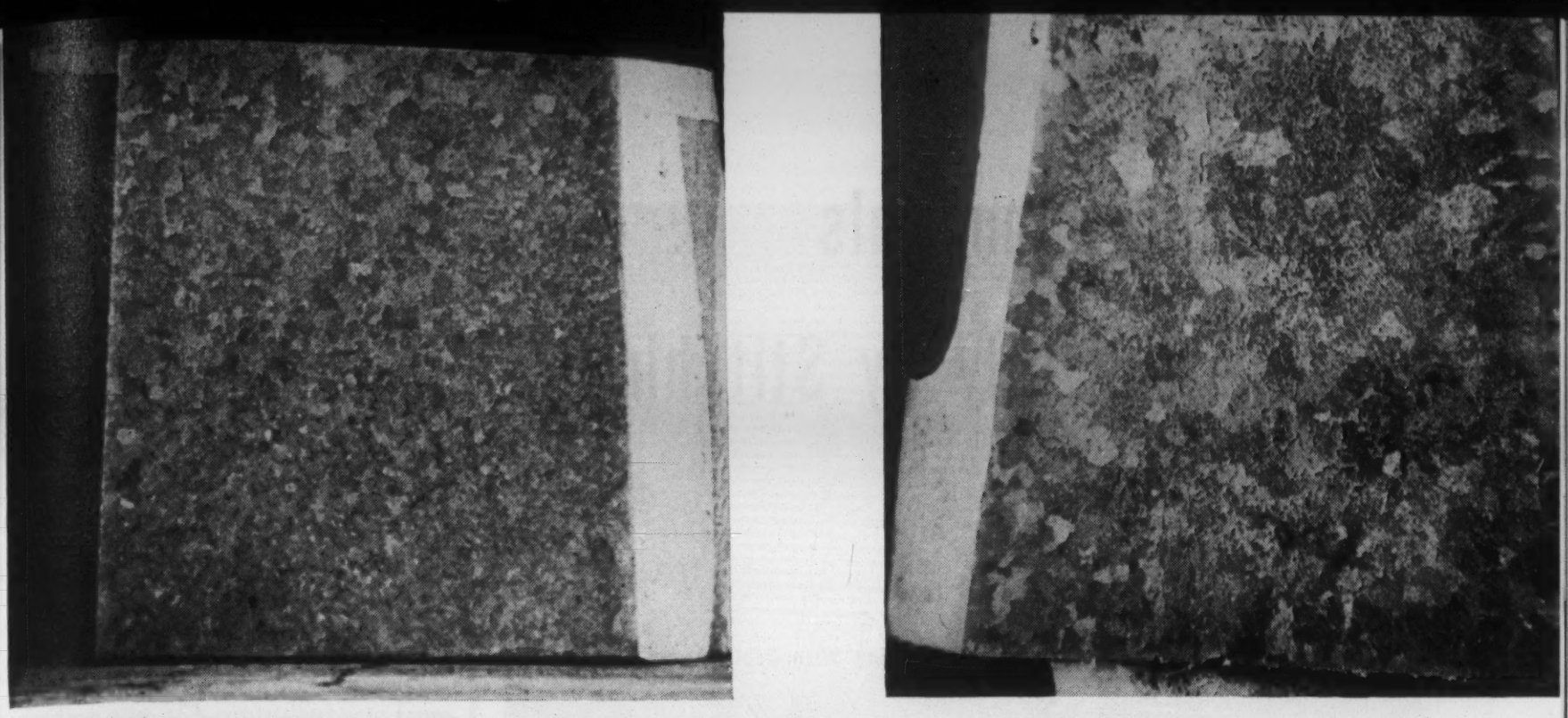


Fig 5—Macrographs of castings with good (left) and poor (right) metal structure.

porosity was great enough to eliminate any possibility of the castings being usable. In this classification checking has proven that the metal quality of castings was very poor.

Fig 3 shows a group of castings that have been classified. Note the paint color on the castings and the areas outlined which had been radiographed. Positive photographs of actual negatives of castings and of each of the three groups or classifications are shown in Fig 4.

A standard metallurgical technique was developed in an effort to double check the x-ray findings. Representative castings were sectioned on the bandsaw and subsequently machined to a smooth finish by shaping, which brings out the grain structure to a certain extent, and finally, macro-etched by immersion. It has been found that a uniform grain structure and equiaxed individual grains are, generally speaking, indicative of a sound casting. Defects, such as porosity, blow holes, etc., will be readily visible to the naked eye after this preparation. In all but a few exceptional cases 100% agreement was found to exist between the findings of the x-ray examination and metallurgical investigation.

Fig 5 shows macrographs of typical good and poor metal structures. Fig 6 shows a photomicrograph of good metal structure.

Advantages Gained

With the adoption of this practice and subsequent additions to it, lost machine time was eliminated, machining and material costs were reduced, and quality was improved. Savings have also resulted to the suppliers. Because of the thorough and rigid inspection to which the castings are subjected, more care is taken in the foundry, resulting in increased yields of acceptable castings and the reduction of foundry losses.

An additional advantage is that the life of the valves has been definitely extended. To what extent, it is impossible to say, because sufficient time has not elapsed. It is known, however, that an increase has taken place, particularly when they are used under varying corrosive conditions in handling many different products. The elimination of the porosity on the finished surfaces is believed to make it more difficult for the various media to attack the metal. The feeling is that when the porosity reaches the machined surfaces and is exposed to these products, that the porosity provides easier access to the metal and that something similar to intergranular corrosion takes place.

In the beginning, the foundry reaction was one of opposition. However, this is now changed. On any new production the foundries will not begin production runs until the samples have been submitted for x-ray examination and the complete results reported to them. If it is found necessary, changes are made in the foundries' techniques, such as method of gating or risering, pouring temperatures, etc. Once a satisfactory casting has been secured, they apparently experience little difficulty in maintaining this quality.

At present, when rough castings are received from the foundry, they are impounded immediately upon receipt and 5% are inspected or examined by the x-ray method. Never less than two castings are used to check a given heat of metal. If more than 10% of the samples are classified as "not acceptable", an additional 10% of the original shipment is inspected. If more than 10% of the second lot fails, the entire lot of castings from that particular heat is rejected. It is worthy of note that rejections have been reduced to probably less than 2% of the castings received. This has resulted in the increasing of production runs with the assurance that the assembled product will satisfactorily pass the required tests.

Fig 6—A photomicrograph of a good metal structure.

This paper has been based on experience with approximately 50,000 Merco Bronze castings for Nordstrom Valves. However, with some modification, it is being used on other nonferrous metals, such as Mercoloy, monel and nickel. It is being extended to other products where metal quality is a prime requisite.

Metals and Nonmetals Joined Efficiently by Stitching

by ARTHUR G. DENNE, Manager, Round Stitching Wire Dept., Acme Steel Co.

Metal stitching is a low-cost, high production mechanical fastening method that has proved successful for joining thin sections in a wide range of materials.

● A MECHANICAL FASTENING method that is presently receiving increased attention for joining metals and nonmetals to themselves or to each other is metal stitching. This fastening technique is a low-cost, high-production method in its own field of application, and the bond obtained compares favorably in strength and durability with riveting or welding in the gages for which stitching can be used.

Stitching at Mission Appliance Corp. replaces screws in construction of space heaters.

Metal stitching is accomplished by forming a wire stitch and driving it through the pieces to be joined and clinching it on the far side. The machinery to perform the stitching is relatively simple, and the bond formed is semi-permanent—that is, although not intended to be taken apart, the components can be disassembled without seriously damaging them. Stitching resembles riveting somewhat, but has a field of usefulness of its own with both advantages and disadvantages over other joining methods.

Although stitching of books and cartons and other nonmetal assemblies goes back many years, the first machine designed specifically for stitching through metal was produced in 1938 and was used by the automobile industry to stitch fiberboard tacking strips directly to the steel body. Today all the major automobile manufacturers use metal stitching machinery. By 1941, stitching machines were used experimentally in aircraft construction. The soundness of metal stitching was established by fatigue and vibration tests, and in 1943 authorities at Wright Field gave permission to use metal stitching in the manufacture of both secondary structural and nonstructural components for aircraft.

Capabilities and Limitations

The capabilities of metal stitching are:

1. It can be used to join metals and nonmetals, with the components similar or dissimilar. This gives it a range of applications beyond those reached by welding. For example: plywood, rubber, plastics, leather, or asbestos can be stitched to metal; metal sheets can be joined to each other; or similar or dissimilar nonmetallics can be joined together.

Materials most frequently joined by stitching are: cold-rolled steel; galvanized steel; annealed, 1/4-hard, 1/2-hard and full-hard stainless steel; sheet brass; sheet copper; heat treated, clad and extruded aluminum; sheet cork; leather; sheet asbestos; fiberboard; standard and tempered Masonite board; solid wood and plywood; and plastics, especially the phenolics. Recommended maximum thicknesses of these materials for stitching are given in the accompanying table.

It is sometimes possible to exceed these maximum thicknesses. However, if metal parts have been work-hardened in forming, the recommended maximum values may be impossible to stitch. Also, if a larger number of thin sheets are being stitched, they can be joined more easily than one or two heavy sheets of the same total thickness.

2. Metal stitching is a high-speed process. Although the complete machine cycle takes 1/5 sec, the actual penetration and clinching of the stitch requires only 1/30 sec. Stitching machines are capable of speeds of 280 to 325 stitches per min. However, actual production rates are considerably lower because of the time required to position the work. Operating speeds of 80 to 100 stitches per min are representative figures. The number of stitches per assembly, the difficulties of set-up and positioning, and the competence of the operator are other factors in determining operating speed.

3. Preparation of the work is held to a minimum. No special pre-cleaning is necessary to the process, and no drilling or punching of holes is required as for bolting or riveting.

4. Outer surfaces and interior seams protected against rust and corrosion by painted and galvanized coatings are not disturbed when stitches are applied.

5. The stitching operation is simple, and does not require skilled labor. There is no need for alignment of holes, nor for careful positioning of the work.

6. Equipment is simple, and low in first cost and upkeep. Power requirement is small, and no intricate settings of machine controls must be made.

The process has definite limitations to its usefulness. Some of these are:

1. Metal stitching is applicable to metals in relatively thin sections only. The maximum total metal and nonmetallic material thickness that can be stitched is 3/4 in.

2. Only material that can be punched without cracking or break-

ing can be stitched.

3. Metal stitching is not as neat in appearance as well-driven riveting or spot welding. However, narrow-crown stitches have recently been developed and, being far neater looking, will probably tend to overcome this objection. Stitches cannot be finished to a flush surface except in soft nonmetallics. The widest use of metal stitching is in joining concealed or inconspicuous parts of an assembly.

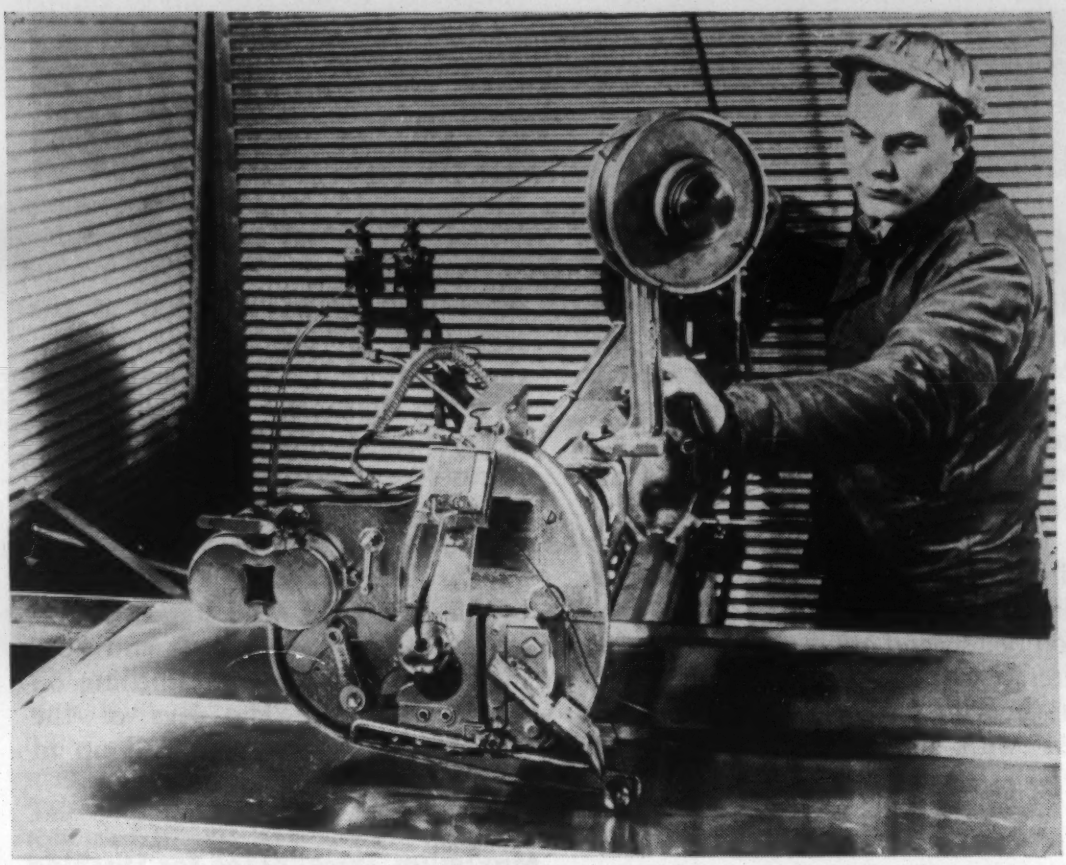
The Stitching Process

The stitching operation consists of feeding wire at a controlled rate from a coil through two feed rolls, a curved guide, a straightener, a round shearing die and into a mandrel. Here, a shearing knife, attached to a knife holder and driven by a cam, cuts the wire after it is gripped in the mandrel. On some models an adjustable wire stop is provided to prevent wire jumping at cut-off. This does not limit the wire feed but acts as a positive centering device, keeping the stitch legs equal. The mandrel carries the piece of wire, now cut to stitch length, under the formers. The formers are moved down, bending the wire over the mandrel into the form of an open stitch. The mandrel then returns to its original position to receive the next stitch.

The formed stitch, now held in the guide ways of the formers, is brought down to the surface of the work while the formers clamp the work in position. This clamping is maintained during the remainder of the operation. A driver then forces the stitch through the layers of material being joined. As the driver operates, a shoe supports the three inner surfaces of the wire stitch, while the formers support the outside surface and the driver supports the top.

A cam surface on the front of the shoe, and spring pressure on the back through a roller and plunger, allow the driver to gradually force the shoe out of the way, while furnishing a constant support to the stitch during the driving action. A light compression spring, and a cam surface on the back of the shoe, position the shoe back of the stitch line so it does not interfere with the entry of the next stitch through the work until the top, or crown, of the stitch rests against the top of the material.

The final operation consists of forming the legs of the stitch into either a flat or loop-type clinch. Loop



Stitching through 0.40-in. sheet of aluminum and a 0.72-in. thick structural supporting member.

Metal Stitching Speeds Aluminum Door Assembly

By replacing drilling and riveting with metal stitching, the Tomfohr Overhead Door Co., Portland, Ore., has increased its production of aluminum door assemblies more than 30%. In addition, fastener costs have been lowered approximately 75% and labor charges reduced more than 65%.

Formerly, two men were required for drilling and riveting operations. Working together, they assembled one door every 55 min, or nine doors per 8-hr shift. With metal stitching, one man is now able to complete a door every 45-min, or 12 doors per 8-hr shift.

The metal-stitching technique was decided upon after two other fastening methods failed to produce high-strength assemblies. First to be rejected was spot welding. Of the two sheet-metal surfaces available on these industrial, airplane hangar and domestic-type doors, the corrugated aluminum sheets were impossible to weld and the flat sheets with V-section bracing could be welded only if a special surface preparation was used—and then with difficulty.

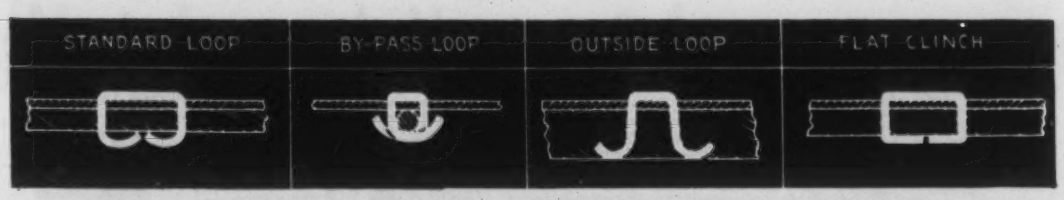
Fastening by riveting produced better results. However, the necessity for hole alignment prior to placement of rivets and the tendency of hand-held rivets to be dropped, consumed valuable production man-hours. More serious than this was the frequency of rejects that were caused by rivets dropping out of their holes.

An average of one door in ten assembled by riveting had to be rejected because of defective rivets. However, not one door in 50 is rejected for defective stitches. Also, the problems connected with hole alignment and the manual handling of rivets are eliminated entirely because the stitch makes its own hole as it is driven and the stitching wire is always in place in the stitching head ready to be formed and driven.

In this application, stitches having 7/16-in. crowns (internal distance between legs), join the sheet aluminum faces of these doors to aluminum structural supporting members. Stitches are formed from 18-gage stainless-steel wire in the following manner: Wire is fed from the 10-lb coil, cut to length, formed into a stitch, driven through the required material thickness, and clinched in 1/5 sec. Because stitches are fully supported as they are driven, they can penetrate thicknesses three to four times their diameters.

A special setup, consisting of a power-operated table, movable in four directions, and an Acme-Morrison metal stitcher with an extended throat was designed and installed by Tomfohr engineers to adapt the production of this 8- by 8-ft all-aluminum door to metal stitching.

Cost per door with metal stitching is $0.087 for the 125 stitches and $0.95 for labor, a total of $1.037. Cost per door with drilling and riveting is $0.33 for the required number of rivets and $3.00 for labor, a total of $3.33. Thus, metal stitching saves this manufacturer $3.33 minus $1.04, or $2.29 per door assembly, and produces more units per day with less rejects.



Four types of stitches are available.

clinches are formed when the legs, after passing through the work, follow the internal contours of various solid clincher dies. Flat clinches are formed when the stitch legs are pressed flat against the bottom of the work by a set of moving clinchers.

Flat-clinched stitches have higher ultimate strengths than the loop-clinched types. They also resist vibration better, and are usually chosen for aircraft work. They are not used with the heavier gages of steel, however, nor with nonmetallic materials of more than ¼-in. thickness as the legs tend to wander when driven through thick materials, and would miss the clinchers.

Loop-clinched stitches take three forms (see sketch): (1) the standard loop clinch, (2) the by-pass loop clinch, and (3) the outward loop clinch. There are also special clincher profiles available. The standard loop is used for joining metals and nonmetallics to metals and clinching on the metal side. The legs of the stitch are curved inward and up to the under surface of the joined materials. The by-pass clinch, in which the legs of the stitch cross to form a single loop the width of the stitch, is used primarily to join bars and tubing of up to ¼-in. dia to sheet stock. Special machines can be manufactured to handle larger diameters. The by-pass clinch is also used to stitch flat metals. When grainy nonmetallics are being joined, the outward clinch, formed by curving both legs of the stitch outward and upward, may be chosen. This clinch can also be used when the clinch is to be placed in softer materials and when greater holding power is required in conjunction with a narrow crown.

Strength of Stitching

Stitching wire in common use is high-carbon steel wire of four nomi-

Maximum Thicknesses for Stitching

	Recommended Max Stitchable Material Thicknesses (in In.) for Loop-Clinched Metal Stitches				Recommended Max Stitchable Material Thicknesses (in In.) for Flat-Clinched Metal Stitches				
	Metal to Metal Any Combination of These		Metal to Non-Metal Any Combination of These		Metal to Metal Any Combination of These		Metal to Non-Metal Any Combination of These		Non-Metals
Aluminum (Soft) 3SO, 52SO, 61SO, Alclad 24SO, R301-O, R301-W, 75SO, 75SW	0.093	0.093	0.125	½	0.093	0.093	0.125	⅛	Sheet cork
Aluminum (1/2 Hard) 3S-H14, 52S-H34	0.064	0.064	0.080	⅜	0.064	0.064	0.080	3/16	Leather
Aluminum (Hard) 61ST6, Alclad 24ST3, Alclad 24ST36, R301-T, 75ST6	0.040	0.040	0.064	¼	0.040	0.040	0.064	3/16	Sheet asbestos
Aluminum Extrusion	0.062	0.062	0.093	½	0.062	0.062	0.093	¼	Fiberboard
1010 Cold-Rolled Steel	0.0475 (18 ga.)	0.0475[1] (18 ga.)	0.0800 (14 ga.)	½	0.0348 (20 ga.)	0.0348 (20 ga.)	0.0348 (20 ga.)	⅜	Sponge rubber
Hot Rolled Steel	0.0475 (18 ga.)	0.0348[1] (20 ga.)	0.0625 (16 ga.)	¼	0.0348 (20 ga.)	0.0348 (20 ga.)	0.0348 (20 ga.)	¼	Solid rubber
Galvanized Sheet	0.0348 (20 ga.)	0.0348[1] (20 ga.)	0.0475 (18 ga.)	⅛	0.0312 (21 ga.)	0.0312 (21 ga.)	0.0312 (21 ga.)	⅛	Phenolics[2]
Stainless (Type 302) Full Hard	0.010	0.010	0.020	3/16	0.010	[4]	0.010	3/16	Plastics[2]
Stainless, 1/2 Hard	0.012	0.012	0.025	⅜	0.012	[4]	0.012	3/16	Standard Masonite
Stainless, 1/4 Hard	0.015	0.015	0.030	¼	0.015	0.015	0.015	¼	Tempered Masonite
Stainless, Annealed	0.020	0.020	0.040	⅜[3]	0.020	0.020	0.020	3/16	Solid wood
Sheet, Brass, Soft	0.030	0.030	0.050	⅜[3]	0.030	0.030	0.040	¼	Plywood
Sheet Copper	0.035	0.035	0.064		0.035	0.035	0.045		

[1] *Rockwell 50 on B scale, or softer.*
[2] *Must be soft enough to penetrate without cracking.*
[3] *Grain structure may cause leg wander in thicknesses over ⅜ in.*
[4] *Stitching full-hard or half-hard stainless to itself is not recommended.*

nal grades, as indicated in the Table below:

Nominal Grade Psi	Tensile Strength Range Psi
230,000	220,000-249,000
260,000	250,000-289,000
290,000	290,000-319,000
330,000	320,000-360,000

All are cold-drawn and will withstand 180-deg bends without cracking or breaking. Three Washburn and Moen gage sizes are used: the 16-gage, of 0.0625-in. dia; 18-gage, of 0.0475-in. dia; and 20-gage, of 0.0348-in. dia. Standard finishes are tinned, galvanized, liquor and bright. A special wire used for aircraft, or for other applications where high corrosion resistance and good strength are required, is a zinc-coated 18-gage wire of AISI grade C 1086 steel, capable of withstanding 300 hr of standard salt-spray test.

Stitching wire of phosphor bronze, stainless steel, and monel metal are available for special applications. The phosphor bronze wire is usually 18-gage wire, type S-54, while the stainless steel wire is usually AISI type 302.

In addition to the type and size of wire and the type of clinch, the position of the stitch with relation to the direction of pull is important in considering its strength. Stitches that lie parallel to the direction of pull have the lowest shear strengths. Perpendicular stitches have about 15% higher strength. Diagonally-positioned stitches have the same strength as those perpendicularly placed. Diagonal positioning is usually preferable, however, because it gives higher values in two directions. Stitches in tension have much lower strengths than in shear—they have about 45% of the shear strength of stitches perpendicular to line of pull. In general, loop-clinched stitches have about 75% of the strength of flat-clinched stitches. Butting the layers of the work and stitching is not recommended.

As a guide to the strength of metal stitching, flat stitches made with 290,000-psi wire of 0.051-in. dia in aluminum alloy sheets of 0.032- to 0.051-in. thickness, showed an ultimate shear strength averaging about 530 lb per stitch when stitched perpendicular to the line of pull. Parallel stitches showed a strength averaging about 466 lb per stitch. In tension, with the line of pull perpendicular to the sheets, strength was only about 230 lb per stitch.

Typical Uses

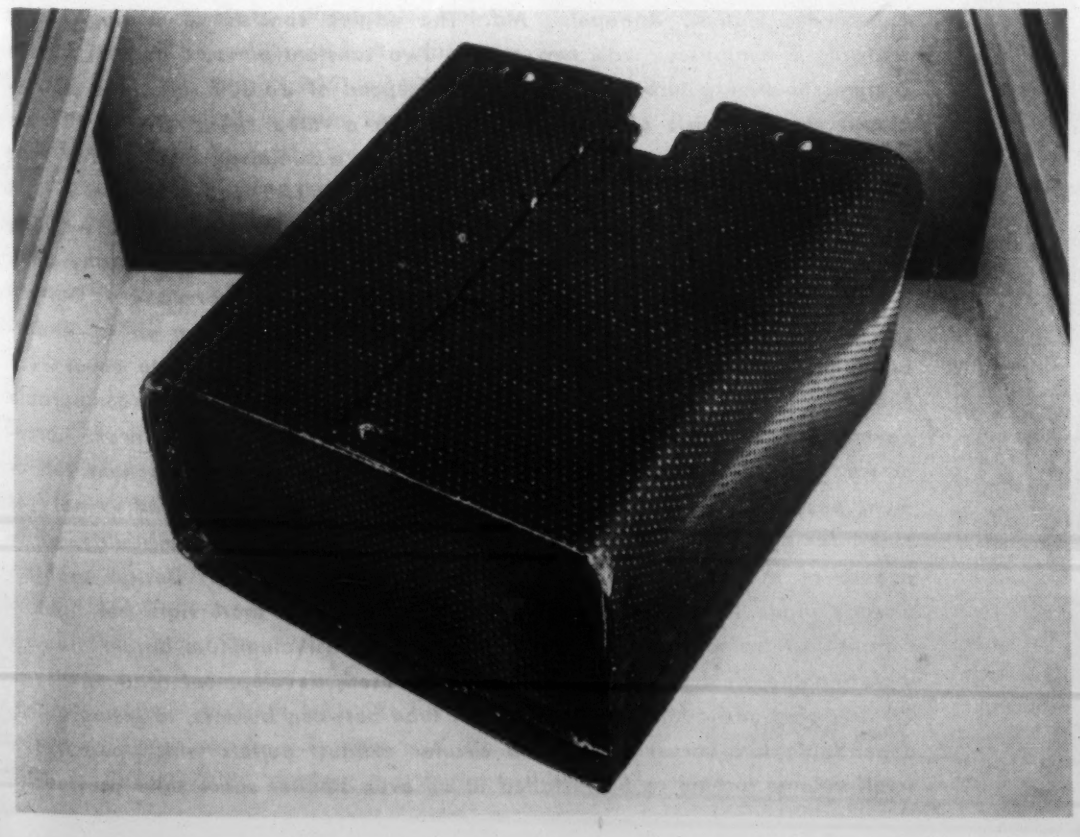
Metal stitching is used in the manufacturing of automobiles, busses, trucks, refrigerators, aircraft, metal furniture, garage doors, air conditioning units, electric ranges, furnaces, toys, novelties, and other items.

The automobile manufacturer who first used metal stitching to join tacking strips to steel saved approximately $60,000 the first year by their use. Metal stitches replace drive screws in construction of space heaters by Mission Appliance Co., and materials and man-hours are saved. The company formerly used 32 sheet-metal drive screws, driven by hand with a screw driver, to join heater components. The same number of metal stitches are now made by machine. Fastener costs with stitching are $0.33 per hundred furnace units vs a former cost of $7.87. The saving in time is 3½ man-hours per day.

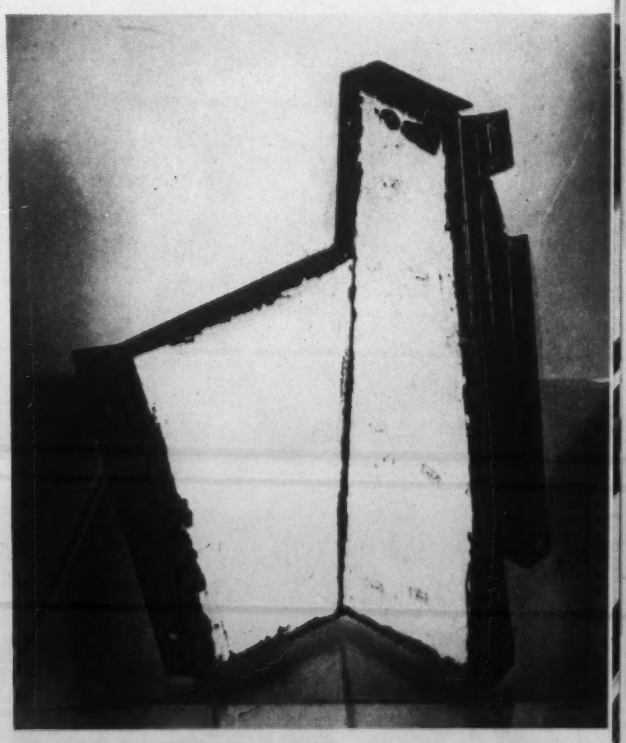
Rubber pads are stitched to the bottoms of aluminum ladder legs at the plant of Bardwell and McAllister, Inc. The stitches pass through three layers of material in making this assembly, including ¼ in. of rubber and 0.093 in. of aluminum extrusion. Four screws, nuts and washers were saved on each ladder leg, and the company reports that the present method affords increased strength and rigidity. Time saved was 2 min per ladder.

Asbestos cloth was formerly riveted to a steel frame in fabricating a furnace component at Holland Furnace Co. By stitching through the sheet metal, the asbestos cloth, and a second layer of steel sheet, a material saving of 6%, along with a labor saving of 82%, was obtained by the company. Production of these components was increased 6½ times by making the change.

This metal-clad auto glove compartment, produced by Woodall Industries, is assembled by stitching.



This application of metal stitching at General Motor Truck involves fastening compressed asbestos to steel.

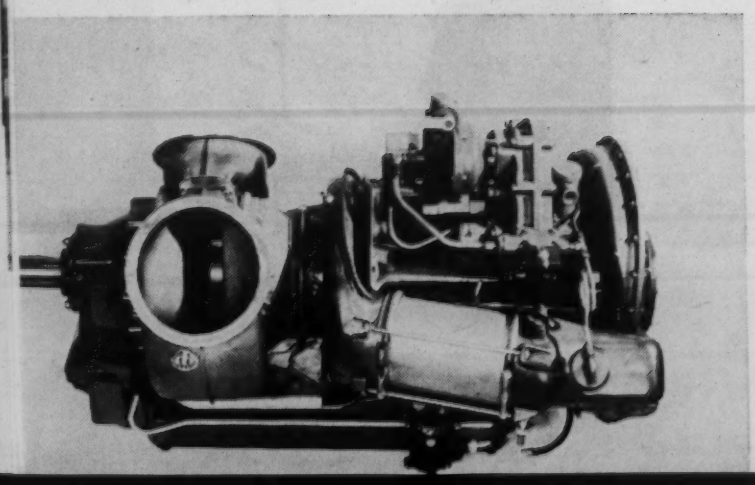


Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

Older, basic materials in new applications . . .



MATERIALS IN SMALL BOAT GAS TURBINE

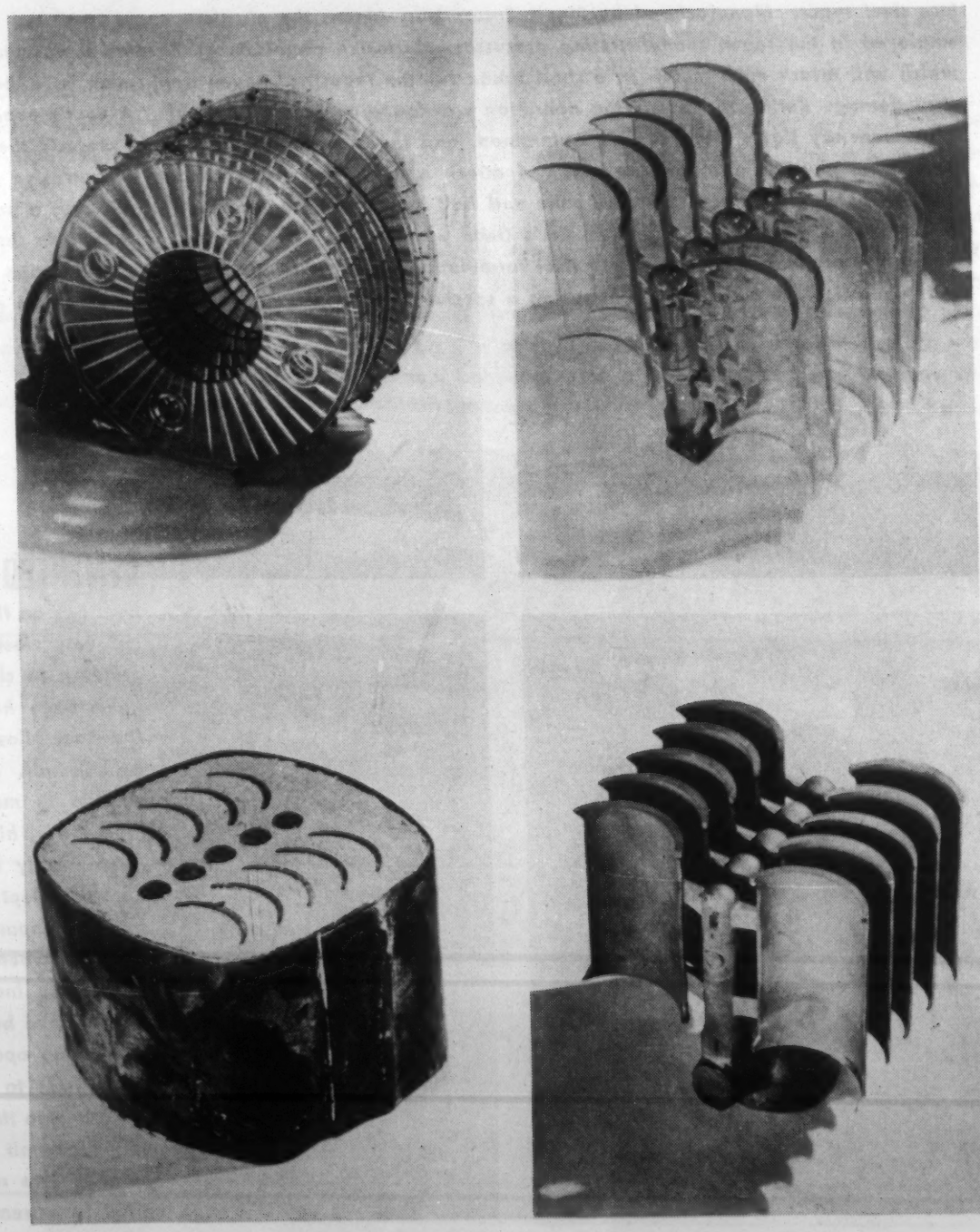
To find out whether gas turbines are suitable for propelling small boats, the Navy is now testing a 24-ft boat fitted with a 175-hp turbine at the U. S. Naval Engineering Experiment Station, Annapolis, Md. The engine consists of a single-stage centrifugal compressor with two outlets, two constant-pressure burners, and a compressor-driving turbine having a rated speed of 36,000 rpm. The power-output stage consists of another turbine with a rated speed of 24,000 rpm and 9.6 to 1 reduction gear. To keep weight to a minimum, aluminum is used for a number of major components. Weighing only 150 lb, the engine is light enough for two men to lift and occupies less space than a household washing machine. Maintenance is simple, as there are about one-tenth as many parts as in a conventional gasoline or oil engine of comparable horsepower. Out-put will vary between 100- and 200-brake horsepower, depending on the endurance life expected. The turbine can drive the boat at speeds up to about 21.7 knots with much less vibration than a diesel or gasoline engine of comparable power. Fuel consumption will vary between 1.5 and 1.0 lb per brake horsepower hour, depending on the rating and the degree of component refinement possible. The turbine is still in the development stage and is not yet ready for production. Although emphasis has been placed on reliability, other phases of the turbine's proving have not been neglected. Design changes already made to improve operation of the unit are: a more rigid but lighter-weight cast frame; a new accessory drive unit; cast aluminum burner elbows, replacing the steel fabricated ones formerly used; development of a new-type ignition plug and addition of a crossover tube between burners, to insure quick, dependable two-burner starts; and circular exhaust outlets which permit the small volume turbine to be installed in an even smaller space than previously.

RIGIDIZED METAL SPEAKER GRILL

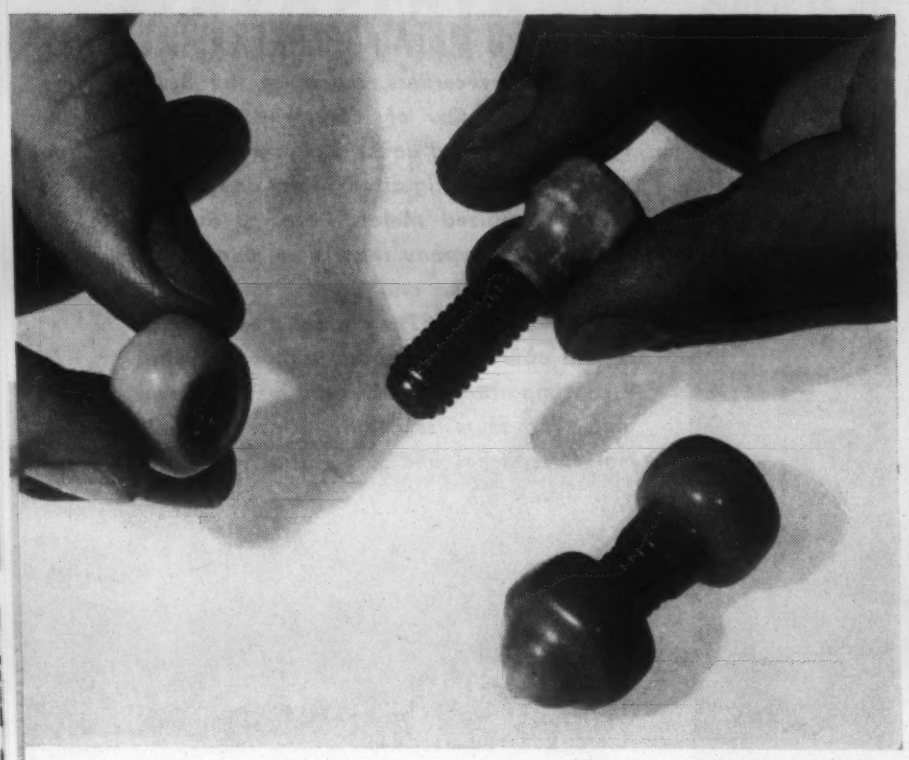
Brush tape recorders, made by the Brush Development Co. of Cleveland, combine utility with good looks by using speaker grills made of Rigidized Metal, a product of the Rigidized Metals Corp. of Buffalo, N. Y. The company reports no measurable sound obstruction and greater tone fidelity with these grills. The rigidized metal grill is also able to take abuse without showing it, an important characteristic in a portable unit. The more resistant surface conceals marks, scratches and fingerprints.

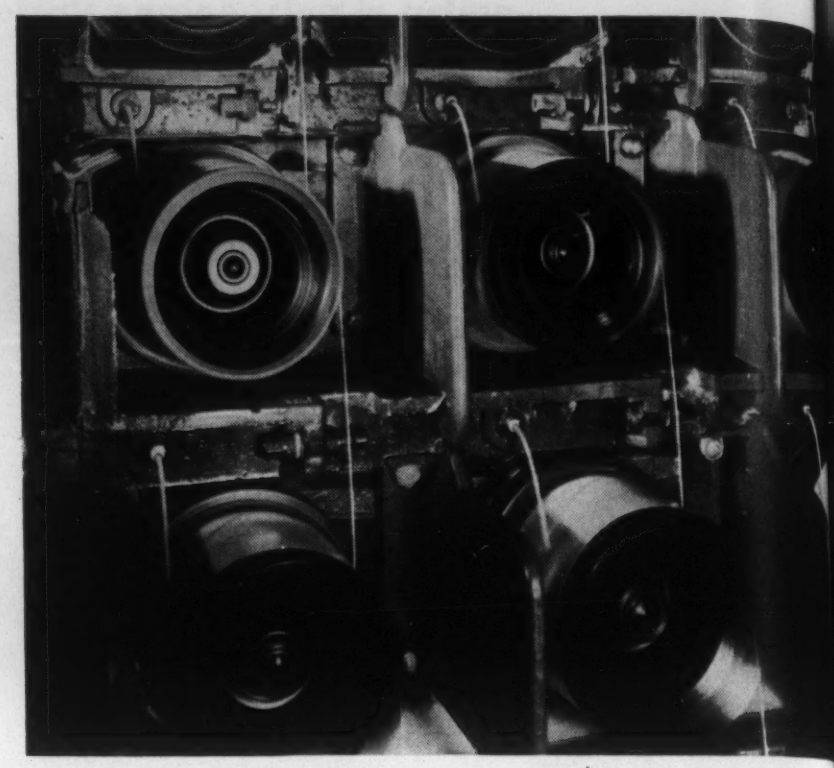
STYRENE PRECISION INVESTMENT CASTING PATTERNS

Precision investment castings are being made with accurate, uniform disposable patterns made of Bakelite styrene plastic. Castings are held to ±0.005 in. on long production runs by the Haynes Stellite Co. of Kokomo, Ind. Production runs as high as 250,000 pieces, with parts ranging from several hundredths of a lb up to 15 lb, are being made. The styrene patterns are strong and resilient, can be cast with sections as thin as 0.012 in., and give good finish and accuracy in the final metal casting. Injection molding of styrene patterns reduces pattern costs when production quantities are large enough to absorb high mold costs. Typical investment castings include lifter plates for sealing cans (pattern top left) and gas turbine blades (pattern top right). The pattern is injection molded, coated with fine silica sand and mounted in a flask that is invested with more sand and ethyl silicate (bottom left). The styrene melts and burns out in a furnace and the metal is poured in to produce the casting (bottom right).



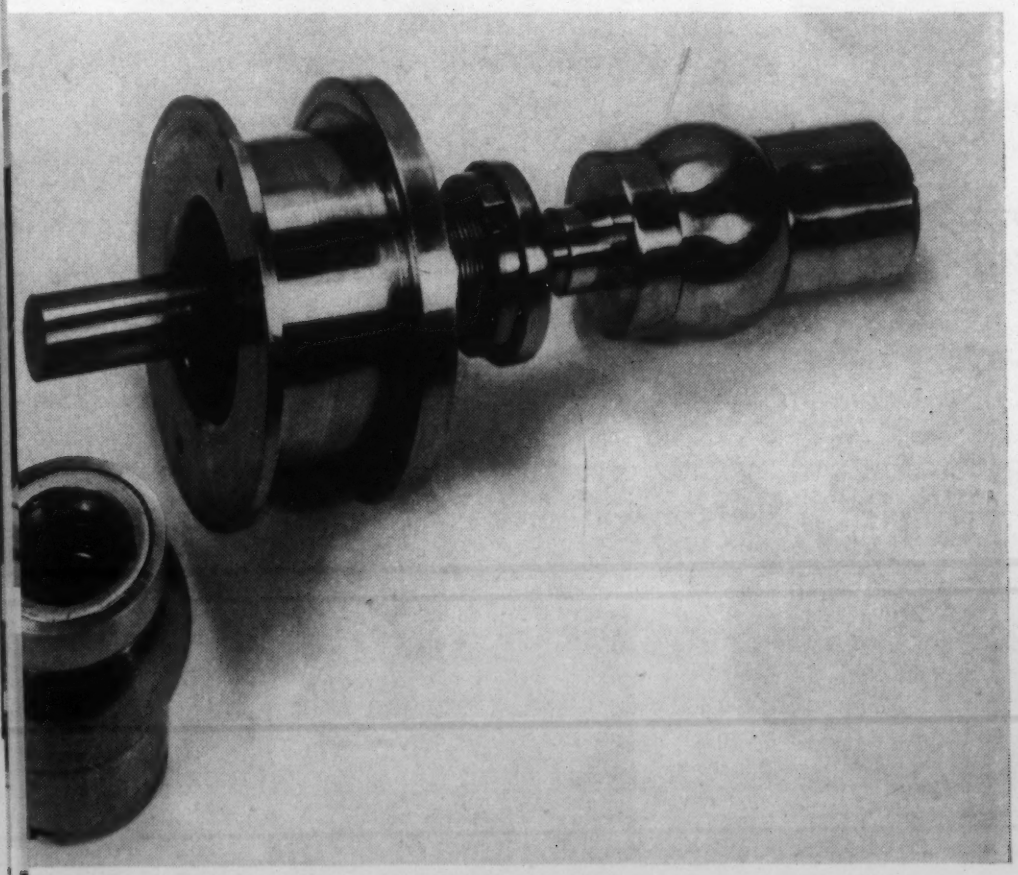
Materials at Work





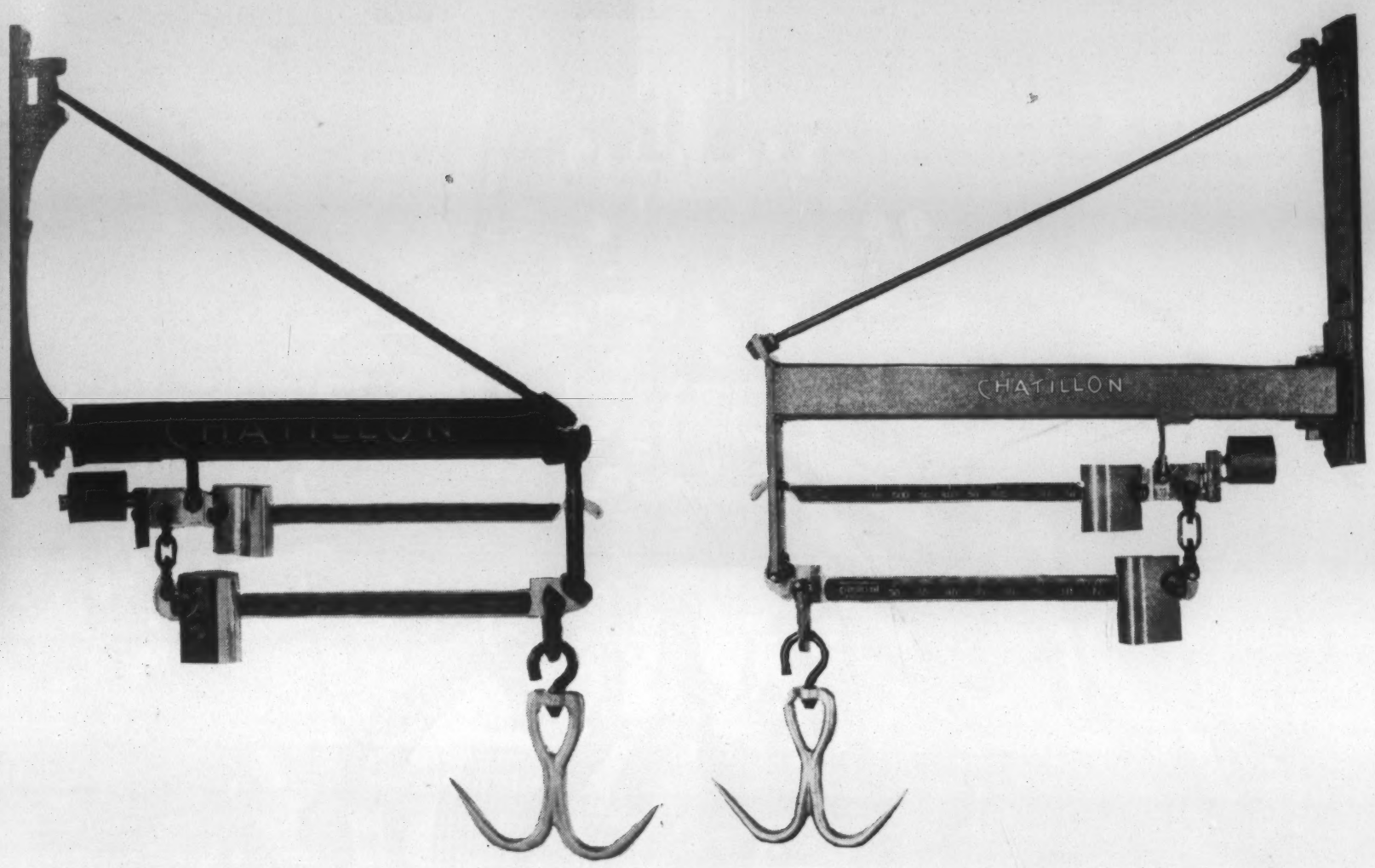
PLASTIC COATED FASTENERS

Expensive stainless steel nuts and bolts and special rubber sealing gaskets used in corrosive chemical baths are being replaced by vinyl encased low carbon nuts and bolts by Industrial Rayon Corp., Cleveland. Not only does the conversion represent a considerable cost savings—the vinyl encased nuts and bolts (patent applied for) cost approximately 14% as much as the stainless steel variety—but also, the plastic-covered nuts and bolts resist chemical corrosion much better than do the ordinary stainless steel types. Manufactured by Steere Enterprises, Akron, the plastic encased nuts and bolts are used in long narrow tanks, or baths, employed in the rayon manufacturing processes. Corrosive chemicals at elevated temperatures are used in these processes—a combination which will attack most metals in a short time. For the Industrial Rayon application, a 3/64-in. semi-hard vinyl coating which resists physical damage during the wrenching operation was found to be most suitable. A year's experience with these nuts and bolts has shown that a permanently liquid tight seal is maintained, and that the coating effectively protects the metal. Even when the coating has been ruptured from physical damage, the chemical attack is limited to that area and the corrosion products seal the wound and prevent continuing reaction. The plastic vinyl encased nuts and bolt heads are manufactured by dipping a properly preheated nut or bolt in a vinyl plastisol, made from B. F. Goodrich Chemical Co.'s Geon paste resin. The thickness of coating in this process (patent applied for) depends upon the amount of preheat, the type of plastisol formulation, and the length of time of immersion in the plastisol. Through proper compounding of the plastisol formulation and by using a special hardening operation, a coating can be given a hardness in excess of 100 Durometer A.



CEMENTED CARBIDE BEARINGS

Cemented carbide bearings on the spindle of a Brown and Sharpe grinder permit very close bearing tolerances and, consequently, allow grinding to closer tolerances. Parts ground on this machine have been held to 0.0001 in., permitting a reduction in the stock allowed for lapping and reducing the lapping time by one-half. Development of bearings of cemented tungsten carbide to meet unusually severe service requirements of high loads, high speeds and elevated temperatures may be commercially realized in the near future, according to the Carboloy Dept. of General Electric Co. Successful experiments by the company seem to indicate that carbide bearings may take up where conventional bearings cannot meet service conditions, including the above variables. In laboratory tests, sleeve bearings in which carbide runs against carbide have been operated successfully at speeds of 30,000 rpm, with loads to 2000 psi. The results obtained have been attributed to the ability of the carbide materials to withstand very high unit pressures, to retain strength at elevated temperatures, to resist deformation, and to their ability to be fitted to extremely close tolerances.

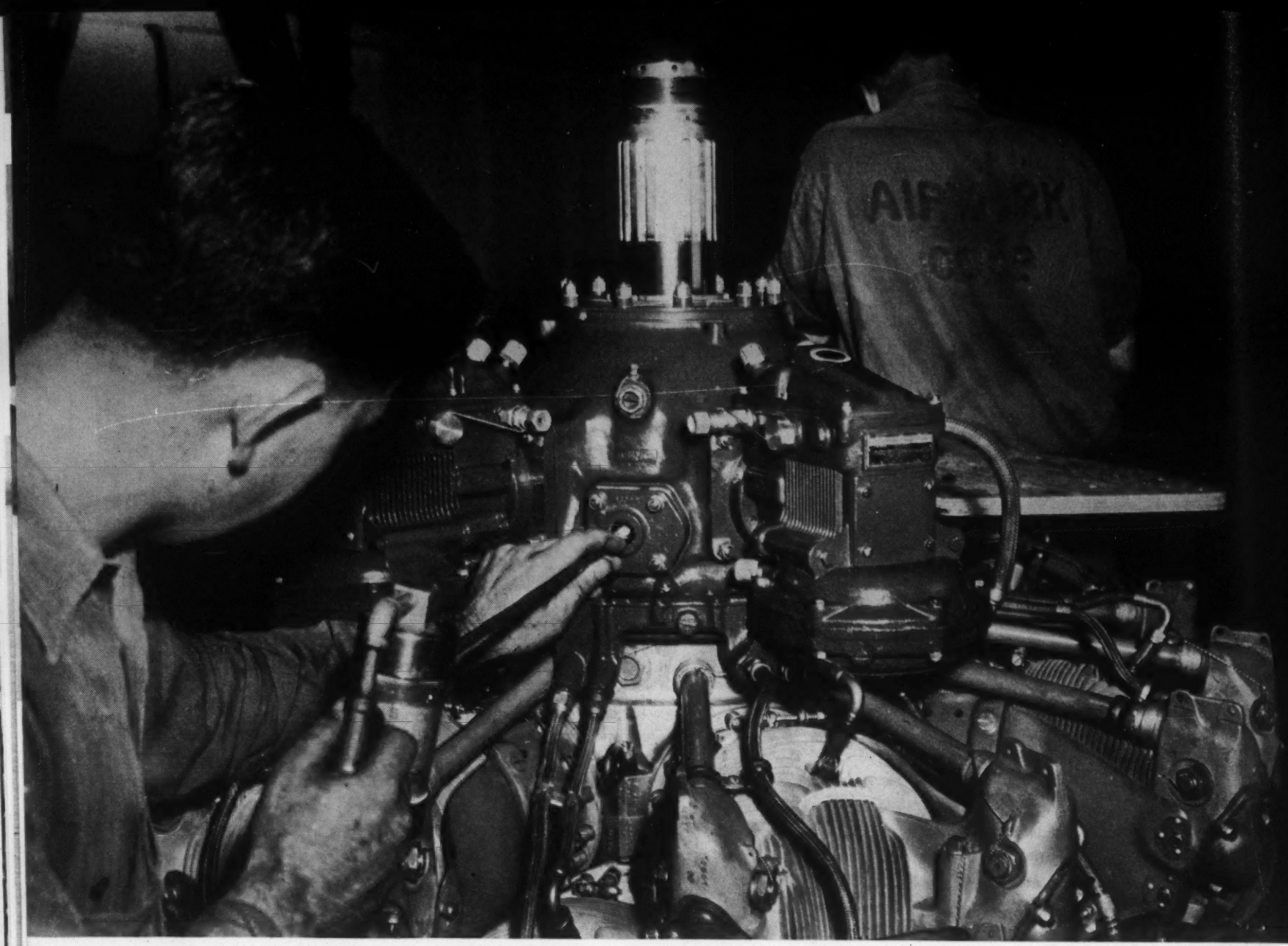


REDESIGNED MEAT BEAM

The present materials situation prompted John Chatillon & Sons of New York to redesign their standard meat beam. The aim was to cut out unnecessarily expensive parts and eliminate hard-to-get items as far as possible. This is a consumer product, and the appearance could not suffer from the redesign. The same accuracy standards had to be met by the new model and performance could not be sacrificed. The old design is shown at the left; the new model is at the right. The biggest modification was the change from cast iron to welded steel for the frame. The wall bracket, formerly a casting, became a cold rolled steel welded assembly. The main horizontal head was changed from cast iron to cold rolled extruded steel at a 20% saving. The vertical hanger, attached to the end of the head in the old model, was welded to the end of the head in the new design. The horizontal numbered scale beams were formerly zinc die castings. These were changed to easy-to-get cold rolled steel, at an 8% saving. The tendency to abandon castings was reversed for the movable weights, however. These weights were machined from steel bar stock. By switching to gray iron castings, the company reaped a 40% saving.

CELLULOSE ACETATE BUTYRATE PIPE

Noncorrodible pipe fittings for the oil fields are fabricated from durable Tenite plastic, the same tough material now widely used for oil field piping. Threaded or slip-sleeve, the fittings are produced in a great variety of sizes and shapes. Slip-sleeve couplings can be quickly installed, permanently bonded, in Tenite lines by use of a cement and thinner having an affinity with the plastic. The light weight and high impact strength of Tenite make the fittings easy and advantageous to handle. Installed, these long-wearing Tenite parts prove exceptionally resistant to weather and soil conditions. Pipe fittings are fabricated by Green Contracting and Engineering Co., Wichita, Kan.; extruded pipe by Carlon Products Corp., Cleveland. The plastic used is cellulose acetate butyrate Tenite, a product of Tennessee Eastman Co., Div. of Eastman Kodak Co.



One of the earliest commercial applications of the new volatile crystals was in the prevention of corrosion in stored aircraft engines.

Volatile Crystals Prevent Corrosion of Packaged Steel Parts

by **PHILIP O'KEEFE, JR., Associate Editor, Materials & Methods**

In spray, dip or powder form, this new anti-rust compound protects steel without use of heavy, hard-to-clean coatings.

● AFTER WORLD WAR II, hundreds of Navy ships and billions of dollars worth of military equipment were put into "moth balls", as the newspapers phrased it. Recently, an anti-rust packaging treatment has been perfected which actually fits the term far better than the cosmoline and coating methods used then. The steel is actually protected in somewhat the same way that moth balls guard wool.

The new method of preventing the corrosion of packaged steel articles by moisture is being marketed by the Shell Oil Co. No greases or liquid protectives that must be cleaned off before the steel is used are necessary. The active substance is a slightly volatile nitrite salt, dicyclohexlammonium nitrate, marketed under the trade name VPI. The vapor from the crystals condenses on the metal surfaces or dissolves in condensing moisture. The steel is not protected in open areas and must be enclosed, although hermetic sealing is not necessary. VPI can be applied as a powder, dissolved in alcohol and sprayed, put into solution for metal dips, or used as a coating on wrapping papers.

The duration of protection depends on the amount of inhibitor used and how fast it is lost by leaks and decomposition. According to Shell, the crystals and the vapor have no undesirable effects on non-metals,

nonferrous metals, bimetallic couples or people who come in contact with them.

Properties

Sodium nitrite is an effective rust inhibitor in oxygen-containing water. Even minute concentrations completely prevent corrosion. This action is due to the nitrite irons, and any salt giving nitrite irons in a basic solution seems to give similar protection. Shell's research settled on VPI, mainly because of its chemical stability. This solid nitrite also differs from the alkali metal nitrites in that it is slightly volatile at atmospheric temperature. This volatility makes it possible to prevent corrosion in packages without coating the metal directly.

VPI is a white crystalline solid that melts at 310 F without decomposing. The pH of its water solution is 7. VPI is practically odorless, and its vapor pressures range from 0.007 x 10^3 mm mercury at 30 F to 12 x 10^3 mm mercury at 150 F. One gram saturates about 20,000 cu ft of air at room temperature. The compound is moderately soluble in water, very soluble in methyl alcohol, slightly soluble in low molecular weight polar solvents, and practically insoluble in hydrocarbons. Considerably increased solubility is obtained by mixing alcohols and water in the right proportions.

Test Results

Many corrosion tests have been made, mostly with impregnated wrapping paper, both outdoors and in laboratories. Steel completely immersed in still water is protected perfectly at concentrations of VPI down to 0.1%. On partially submerged strips, complete protection is obtained with a concentration of 4.0%, but the tendency to rust increases as the concentration is lowered. Steel strips suspended in test tubes at 100 F, 100% humidity, are protected for 21 days by covering the inside surface of the tube with paper carrying 0.106 oz per sq ft, while 0.035 oz per sq ft paper prevents corrosion for only a few days. The protection of VPI paper is proportional to the amount of the crystals initially present. In vapor phase tests at 150 F, 0.176 oz of crystals in a quart bottle protects steel for six months. VPI coated packages in cardboard boxes give excellent protection in laboratory humidifiers in which 95 to 100% humidity air is passed over the boxes at 20 ft per min for 28 days. Similar results are obtained in preventing further corrosion on partially rusted specimens and at sub-zero temperatures.

Many tests in outdoor exposure have been made with steel in different shapes in a variety of treated paper packages. These tests were run under partial shelter and on completely exposed sites on San Francisco Bay. Excellent protection was obtained over 4- to 5-year periods. The protection was better than that obtained with good rust-preventive oils. Oil films on the steel did not diminish the degree or duration of the protection provided. Although soaking the paper in oil reduces the vaporization of the crystals, no decrease in its protective value was observed in moderately severe corrosion tests.

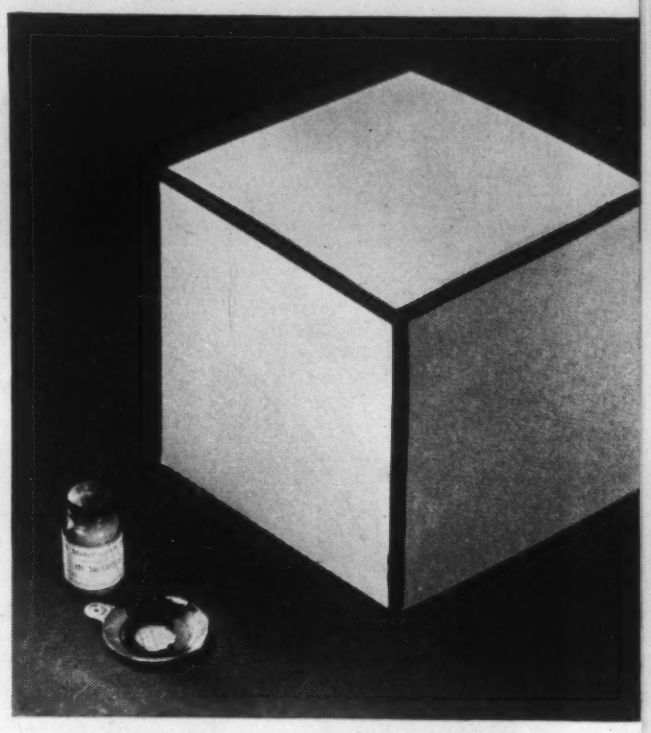
The effect of VPI solutions on nonferrous metals varies. Several metals show a somewhat greater weight loss than in water, but magnesium, zinc and cadmium are the only ones affected to a significant degree. With galvanic couples between steel and nonferrous metals, corrosion rates of the nonferrous anodes are not increased significantly except with cadmium, zinc and lead-tin solder. These tests are run in solutions and results are highly variable in vapor phase tests.

Most nonmetallic materials that have been tested show no effects aside from color changes in a few. Films of rubber hydrochloride show marked deterioration, however, and mild effects are found on cellulose nitrate film.

The compound is rapidly depleted by water draining from the treated paper package. Localized depletion can also occur at spots where the inhibitor paper touches steel, but this can be avoided by proper package design. Vapor losses are low if air currents are prevented from sweeping directly over the crystals. This is usually done by overwrapping an extra layer of paper or by putting the package in a cardboard box. The storage stability of treated papers is good, but the crystals themselves are decomposed by prolonged exposure to direct sunlight.

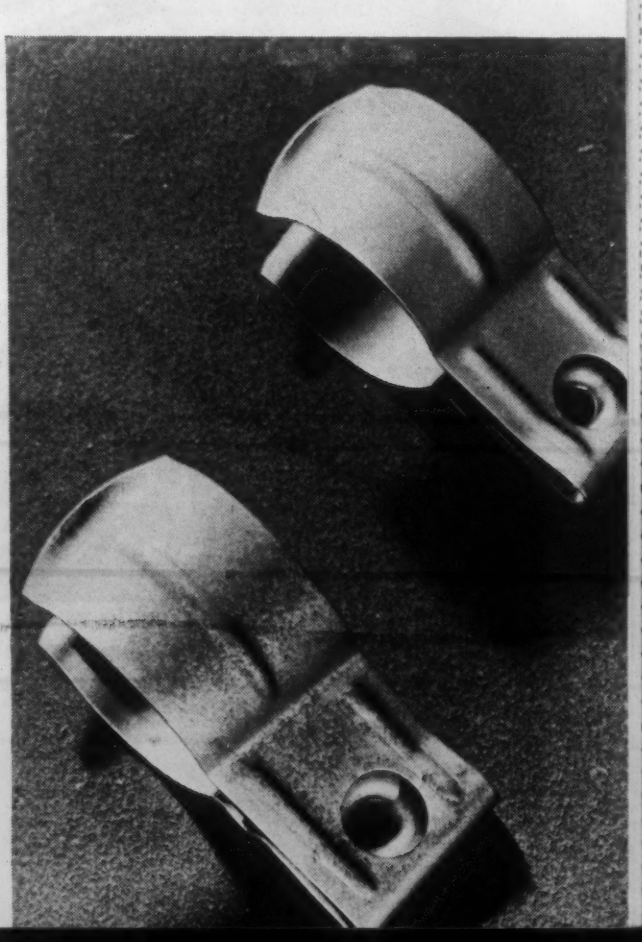
Industrial Applications

Although VPI is relatively new to industry, a number of applications have proved to be practical, effective and economical. Pan American World Airways, as the oldest user of VPI, has had several years' experience in using the chemical to preserve aircraft engines during extended storage in highly humid areas. On a test basis, two engines were stored for six months in Honolulu in unsealed cocoons with VPI. Although considerable corrosion normally takes place in an engine under such conditions, these two engines were subsequently placed in service and operated successfully for 1200 hr before



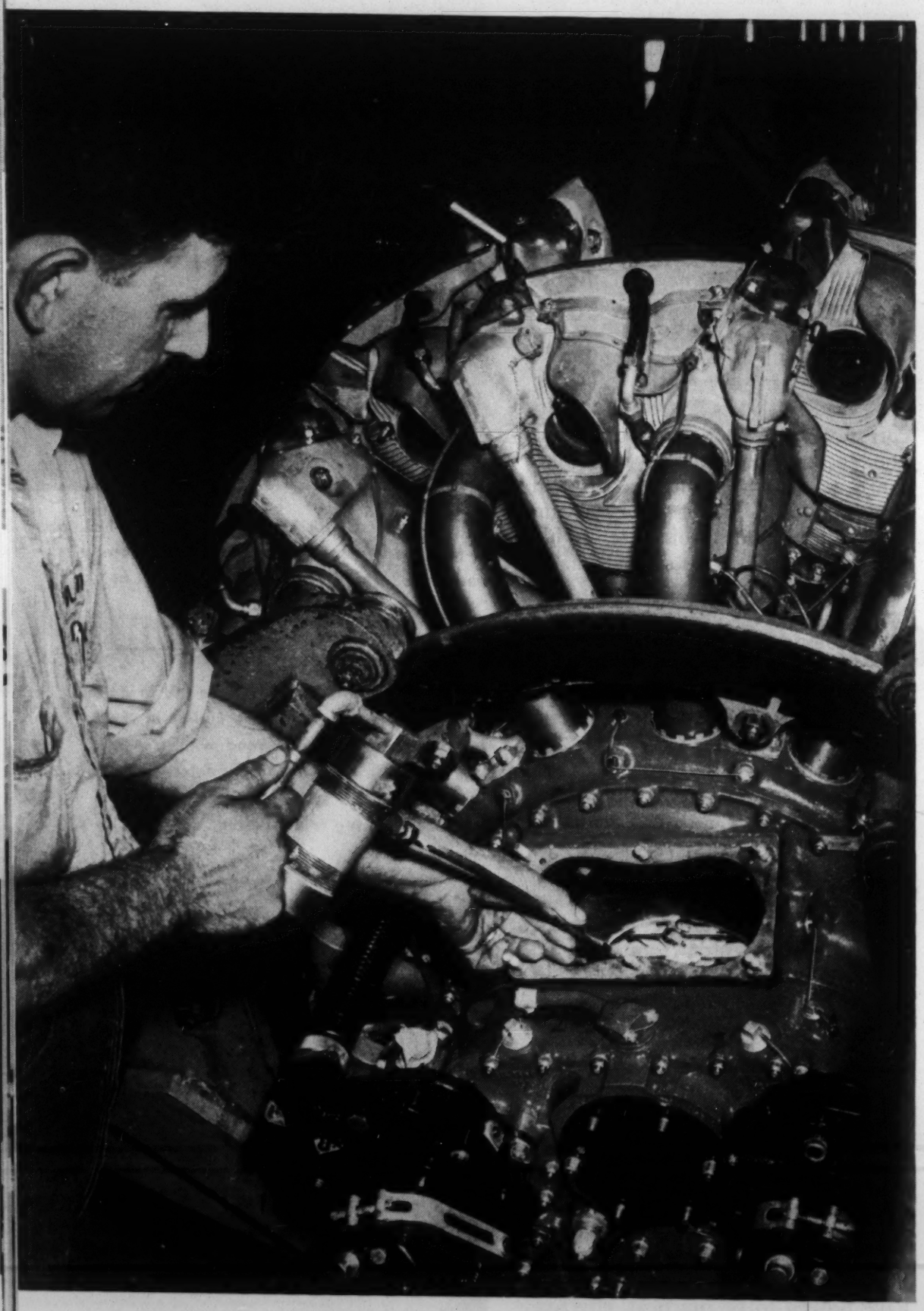
Articles treated with VPI must be enclosed to hold the vapors in and maintain corrosion resistance. Their containers need not be airtight, however.

These two identical springs were left in an open box for 3 weeks. The spring at the left was sprayed beforehand with a 4% water solution of VPI. The untreated spring at the right was rusted, while the treated spring is unaffected.



removal for routine overhaul. United Airlines preserved two engines in the usual manner, then treated them with VPI and stored them for a year. No corrosion occurred during this time. The method of application in preserving engines is to blow the powder into the various functional surfaces, such as cylinder bores, with a small compressed air gun. A paper barrier is then wrapped around the engine to prevent the loss of the VPI vapor.

VPI is now being used by a number of companies for preventing corrosion during storage and shipment, particularly where metal products are stored for a considerable time before being used. Typical of products being treated in this manner are ball bearings, water pumps, industrial filters, castings and forgings, precision nuts and bolts, tools and dies. A small amount of VPI is placed in the shipping packages for these products and it has not been necessary to have either air or water-tight wrappings to hold the vapor. It has been found that 2 hr must elapse before VPI becomes completely vaporized and assumes its protective role, and procedure should be governed accordingly. The quantity of VPI to be used in the protection of steel parts varies somewhat, but approximately 1 g, used under proper conditions, will protect a cubic foot of steel parts.



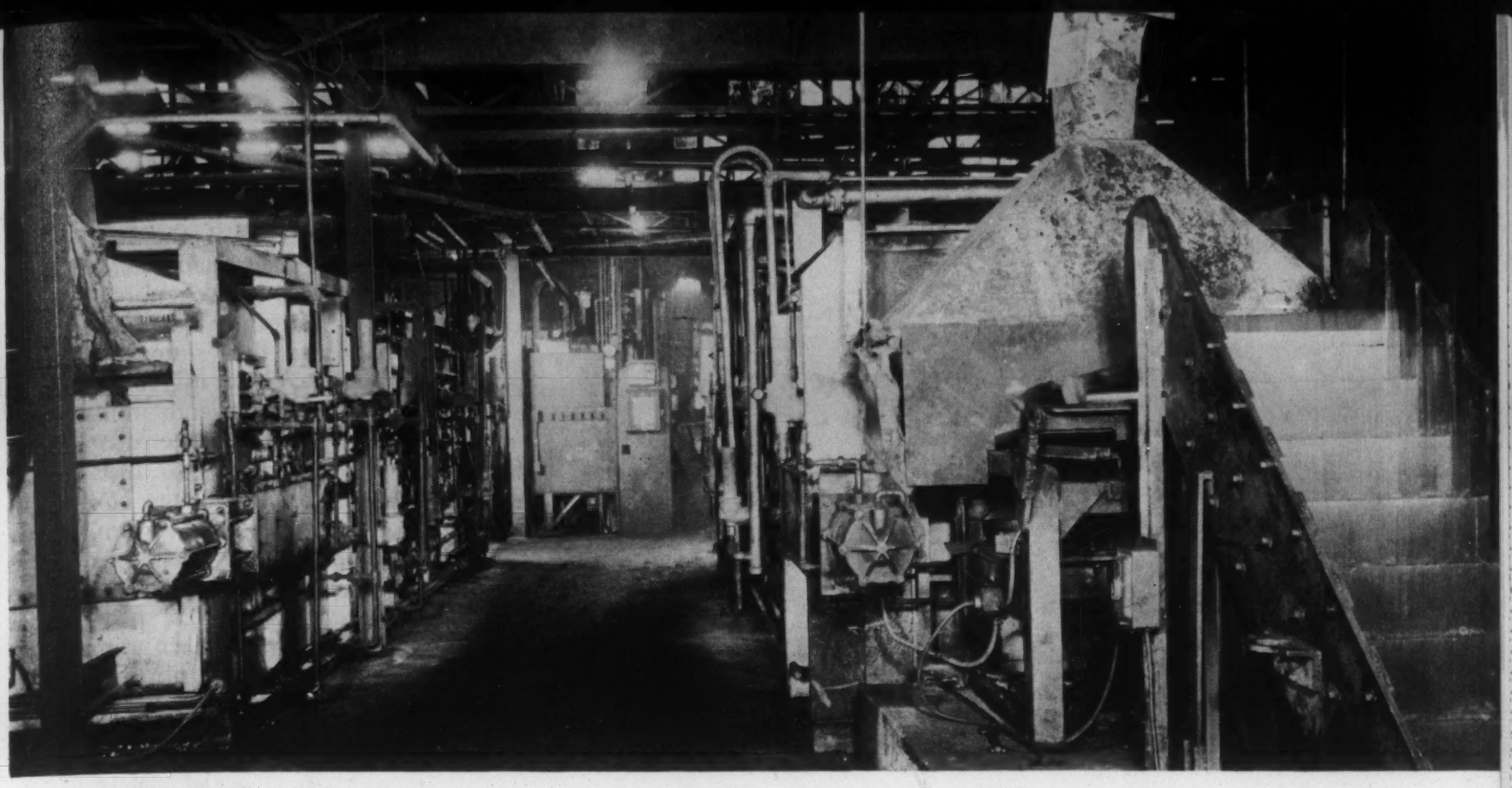
In preserving aircraft engines, the powder is blown into the critical areas with a small air gun. A paper enclosure prevents loss of the vapor.

The use of VPI in solution is opening up a new field of rust prevention in the processing of steel parts. One metal working firm used a 2% solution to protect its steel products between machining and grinding operations, eliminating a previous time-consuming and costly corrosion prevention procedure. About 25 lb of VPI a month protects the plant output, and the strength of solution varies from 2% to 4%. One company is now completing tests on a method of applying the solution to the protection of continuous strip.

One use of VPI which may affect an industry beneficially is its application to emulsifiable paints. Preliminary tests show that VPI adds a rust-preventive quality to this type of paint, making it a good general purpose coating for the metal working industry. This type of paint is highly desirable because it is easy to use, presents no fire hazards, and carries no residual odor. Only the relatively low rust-prevention quality limits its application.

Many companies are currently running extensive tests on VPI to determine just how widely it can be applied to their products, in storage, shipping and between machining operations. Battelle Memorial Institute is also running a series of field tests for the Steel Shipping Container Institute to determine its effectiveness in preventing corrosion of steel drums, and one of the larger steel companies has already established a practice of treating all drums with VPI, assuming no responsibility to those customers who do not purchase units which have been treated in this manner. VPI paper is already being made by a number of paper companies under a licensing arrangement with Shell Oil.

While VPI is not a cure-all, it is a convenient and economic method of preventing and arresting corrosion of steel parts and products, and eliminating substantial man-hours previously assigned to the treatment of products against corrosion.



A pair of continuous Surface Combustion controlled atmosphere radiant tube furnaces used for heat treating parts on a jobbing basis. Speed of conveyors is varied to handle various size parts.

Continuous Furnaces Economically Treat a Variety of Parts

Jobbing shop uses continuous radiant tube units effectively, even though the size and shape of the parts treated is changing constantly.

by CHARLES W. HEILMAN, President, Commonwealth Industries, Inc.

● MOST OF THE PLANTS that heat treat parts for a number of customers on a jobbing basis use batch type furnaces. The size of the parts, the size of the batches and the heat treating specifications from various customers change constantly, and while continuous furnaces have definite advantages over batch type furnaces, they are almost never used. The general supposition has been that continuous furnaces could not be adapted to jobbing work.

Commonwealth Industries, Detroit, Mich., took a different view of the matter. Their business is jobbing work for many companies, heat treating bolts, nuts, screw machine products, forgings, castings and stampings. The work covers a tremendous variety of parts, but the individual parts are small and seldom go above 12 in. in the maximum dimension. This company has been able to use continuous furnaces efficiently and economically. Many parts are processed for large manufacturers whose equipment is overloaded or cannot be adapted easily to the particular parts.

At Commonwealth, scale-free hardening, case carburizing, dry cyaniding and carbonitriding are done in two radiant tube Surface Combustion furnaces. One of these furnaces has a cast conveyor belt of heat resistant alloy, 36 in. wide and 20 ft long, that advances work along the enclosed hearth. The belt can be driven at variable speed. The atmosphere is controlled and is supplied by Surface Combustion RX generators. This atmosphere can be neutral, or enriched with natural gas for carburizing, or enriched with natural gas and ammonia for carbonitriding. The other furnace is of the same make and type, and is used mostly for carburizing, dry cyaniding and carbonitriding. Both furnaces employ radiant tubes for heating. The pressure in these tubes is kept slightly below atmospheric, and any leakage that occurs is from the furnace into the tube, never in the opposite direction. This is important, because leakage into the furnace would alter its atmosphere. There are seals at both ends of the furnace to insure that no air infiltration occurs.

To adapt these furnaces to a variety of parts and to different treatment specifications it is necessary only to control the atmosphere, the

A novel conveyor feeds parts to the furnace. The steps reciprocate in verticle slots, alternate steps moving up and down at the same time. The parts feed from the inclined trough of one step to the trough of the step above as the top step slides down and the lower step slides up. The parts feed up the conveyor in this way.

temperature and the rate at which parts are fed and are carried by the variable speed furnace conveyor. Atmosphere is controlled by setting the RX generators and by admitting natural gas with or without ammonia when either or both are required. Temperature is controlled automatically by varying the feed of gas-air mixture.

Rate of Feed Varied

The chief innovation is in the automatic control of the rate at which parts are fed. This is accomplished by a novel parts loader supplied by the Michigan Crane & Conveyor Co. This conveyor is a set of steps, each of which is constantly reciprocated in a vertical or nearly vertical plane. These steps do not all move together in the same direction; alternate ones move up while the others move down. The top of each step is not flat, but is inclined to form a bucket. As the steps reciprocate, parts are fed up the incline, as shown in the accompanying picture. Parts are dumped into a hopper above the lowest step and feed upward, from step to step. Some parts fall back a step or two, but the flow continues upward. The distribution of parts on the lower steps is not always uniform, but this evens out as they move up.

The rate of feed is varied by varying the rate of reciprocation, which is always slow. This variation is accomplished by a Reeves drive that can be set to give any rate of feed desired. Parts that reach the top step slide off into a chute that delivers them onto the furnace conveyor. By varying the feed, the load is spaced longitidinally on the hearth conveyor in any desired manner. The load is kept even from side to side, so that the entire width of the furnace hearth is utilized.

Heavy parts that heat slowly are fed slowly, and lighter ones that heat more rapidly are fed faster. Thus, the rate in pounds per hour fed can be set and then held substantially constant, regardless of the weight of individual parts. This makes it unnecessary to vary furnace temperature to suit the batch unless the maximum temperature has to be changed to meet different specification. The selection of the sequence of the batches to be treated in one furnace is made on the basis of temperature and soaking requirements, to meet the customer's specifications and at the same time to minimize changes in furnace temperature and in the speed of the furnace belt and loader.

Furnaces are used continuously and are kept at a temperature of 1500 F or above. Once parts are up to temperature, firing in successive radiant tubes is sufficient only to hold the temperature. Furnace life is believed to be increased by the changes in the atmosphere used, because carbon deposited on the alloy tubes and belt parts under carburizing conditions is burned off when a clean hardening atmosphere is used.

Quenching Methods

At the end of the furnace is a 9-ft deep quench tank, holding 4,000 gal of oil that is circulated to maintain a practically constant temperature. Parts drop into this quench through a chute inside the furnace without coming into contact with air. Inside the tank the parts fall onto a flight-type conveyor that deposits the parts either in tote boxes or, if the parts are to be drawn, onto a short portable conveyor having its own separate woven wire belt. This conveyor deposits the parts on the belt that carries them through the recirculating draw furnace.

Parts dumped into the hopper of the furnaces require no handling until they are deposited in tote boxes, either upon exit from the quench or upon dropping from the draw furnace. This helps to keep costs at a minimum, as does the fact that the entire cycle is automatic, once the furnace and atmosphere controls are set to meet a given specification.

Many parts that come from the draw furnace are dropped into boiling soluble oil. As a result, the parts take on an oil coating over the thin oxide formed in the draw operation. A considerable degree of corrosion resistance is imparted to the parts.

Among factors making for economy on parts requiring the carbonitriding is the use of a roof tank that holds 5,000 lb of liquid ammonia. This permits the company to buy ammonia in tank lots, at about half the price for small lot deliveries in small portable high pressure tanks.

Although the furnaces each are rated at a capacity of one ton an hour, this rating has been exceeded. Conveyors feeding the furnaces can be set to feed from about 500 to as much as 4000 lb an hr each. The usual setting is between 600 and 2400 lb per hr per furnace. The furnaces are equipped with fans of 35 nickel-15% chromium alloy that circulate atmosphere gas over the radiant tubes and thereby tend to keep the atmosphere uniform throughout the heating chamber. The fans also increase by 10 to 20% the weight of work that can be handled per hour.

RX generators that feed the furnaces can be set to give almost any desired carburizing potential. This potential is indicated by meters that show the dew point of the atmosphere gas fed to the furnaces. This makes it possible to regulate the depth of case as well as to control the carbon content in the case.

MATERIALS & METHODS MANUAL 77

Titanium
Zirconium
Molybdenum
Tungsten
Tantalum
Columbium
Vanadium
Hafnium

as Engineering Materials

by John L. Everhart, Associate Editor, Materials and Methods

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application.

DECEMBER 1951

These eight metals, which at first glance appear to be a heterogeneous group, have a number of attributes in common, including high melting points and sensitivity to gases. All can now be either hot or cold worked and have been developed to the point where they are now suitable for a wider range of uses. This manual discusses their—

- ***Engineering Properties***
- ***Forming and Machining Characteristics***
- ***Weldability***
- ***Cleaning and Finishing Characteristics***
- ***Present and Potential Uses***

Table 1—Physical Properties

Material	Density Lb/Cu in.	Melting Point, F	Ther Cond, Btu/Sq Ft/Ft Hr/F at 212 F	Coef of Exp, per °F at 70 F	Spec Ht, Btu/Lb/F	Elect Resistance, Microhm-Cm	Elect Cond, % I.A.C.S.	Mod of Elast (Tension), Psi
Titanium	0.16	3140	8.1	5.0×10^{-6}	0.13	60	3.1	15,000,000
Zirconium	0.24	3355	9.6	3.1×10^{-6}	0.069	40	4.3	14,000,000
Molybdenum	0.37	4760	84	3.0×10^{-6}	0.061	5.2 (32 F)	36	42,000,000
Tungsten	0.70	6152	96	2.2×10^{-6}	0.032	5.5 (32 F)	31	50,000,000
Tantalum	0.60	5425	32	3.8×10^{-6}	0.036	12.4 (65 F)	13.9	27,000,000
Columbium	0.31	4380	....	4.0×10^{-6}	0.065	13 (65 F)	13.3	.....
Vanadium	0.23	3110	....	4.8×10^{-6}	0.12	25 (68 F)	6.9	20,000,000
Hafnium	0.47	3400	....	3.4×10^{-6}	0.035	30 (32 F)	5.7	20,000,000

Table 2—Mechanical Properties

Material	Form	Section Size, In.	Condition	Tensile Strength, Psi	Yield Strength (0.2% Offset), Psi	Elong, % 2 In.	Rockwell Hardness
Titanium							
Commercial Titanium, 0.05% C	Sheet	.....	Annealed	70,000	55,000	20-30	A60
			Cold-worked	100,000	85,000	12	.....
Commercial Titanium, 0.20% C	Sheet	.....	Annealed	90,000	80,000	20	A58-62
			Cold-worked, ½ hard	120,000	105,000	12	A61-65
	Bar	.....	Forged	90,000	85,000	15	A58-62
Commercial Titanium, Low C, O, & N	Tubing	.....	Vacuum annealed	78,000	54,000	31	.....
			Cold-worked 18%	96,000	84,000	9	.....
			Cold-worked 55%	124,000	103,000	5	.....
Iodide Titanium	Strip	.....	Vacuum annealed	32,000	17,500	55	.....
			Cold-worked 95%	107,000	90,000	2.5	.....
Zirconium							
Iodide Zirconium Commercial, 3% Hf	Sheet	0.025	Annealed at 1350 F	29,000	10,700	26	.....
			Cold-worked 90%	82,000	58,000	1.5	.....
	Wire	0.125	Annealed at 1350 F	39,500	14,500	33	B42, F83
			Cold-worked 65%	86,000	69,000	17	B87, F105
Kroll Zirconium, ½-3% Hf (Induction Melted in Graphite)	Sheet	0.062	Annealed at 1350 F	59,000	38,000	27	B91
			Cold-worked 60%	90,000	84,300	10	B98
Iodide Zirconium, Low Hf (Arc Melted)	Sheet	.....	Annealed at 1350 F	35,100	15,700	26	B39
Molybdenum							
Molybdenum[1] (From Powder)	Sheet	0.040	Annealed	85,000	.....	4	B95
			Cold-worked	120,000	.....	1	C22
		0.010	Annealed	130,000	.....	7	B95
			Cold-worked	175,000	.....	1	C27
	Rod	0.250	Cold-worked	75,000	.....	5	B90
		0.050	Cold-worked	120,000	.....	5	B100
	Wire	0.025	Annealed	100,000	.....	15	B95
			Cold-worked	130,000	.....	5	B100
		0.005	Annealed	140,000	.....	15	.....
			Cold-worked	190,000	.....	1	.....
Molybdenum[2] (Arc Melted)	Bar	0.5	Annealed at 2000 F	88,000	.....	42	.....
			As rolled	102,000	.....	32	.....
Tungsten[1]	Sheet	0.040	Cold-worked	120,000	.....	0-2	C45
		0.010	Cold-worked	300,000	.....	0-2	C67
	Rod	0.250	Cold-worked	70,000	.....	0-2	C37
		0.100	Cold-worked	150,000	.....	0-2	C40
	Wire	0.025	Cold-worked	225,000	.....	0-2	C44
		0.005	Cold-worked	300,000	.....	0-2	.....
Tantalum[1]	Sheet	0.010	Annealed	50,000	.....	40	E60
			Cold-worked	110,000	.....	1	E95
	Wire	0.002	Annealed	100,000	.....	11	.....
			Cold-worked	180,000	.....	1.5	.....
Columbium[1]	Sheet	.....	Annealed	48,000-59,000	.....	.....	.....
	Wire	.....	Cold-worked	96-000-130,000	.....	.....	.....
Vanadium (Arc Melted)	Strip	0.062	Annealed at 1650 F	72,000	64,000	28	B81
			Cold rolled 75%	113,000	109,000	5	B93
	Bar	0.375	Hot rolled	84,000	72,000	20	.....
Hafnium—Iodide Hafnium	Crystal Bar	.....	As deposited	.....	.....	.....	B78

[1] *Compacted and sintered by powder metallurgical methods, followed by conventional working procedures.*
[2] *Elongation in 1 in. Vickers hardness number: Annealed, 230; as rolled, 255.*

Introduction

During the present century a number of metals, previously considered brittle, have been produced in ductile form. Several of these metals have been commercialized; others are in various stages from the laboratory to the pilot plant. These metals are titanium, zirconium, molybdenum, tantalum, tungsten, columbium, vanadium and hafnium. At first glance, this may appear to be a heterogeneous group. They are, however, all members of the so-called "transition series" of the periodic system, which include some of the most important commercial metals, such as iron and nickel. The transition metals have distinctly different electronic structures from such other metals as aluminum, lead and magnesium, and to this can be attributed their high melting points, high elastic moduli, and relatively high strengths. Many of them, including all those considered in this manual, are quite reactive with gases, a property which has made them difficult to produce with sufficient purity for ductility. However, all have some degree of ductility, although there can be some debate as to whether tungsten can be called ductile in the same sense as titanium and zirconium. Be that as it may, all have been obtained in the form of sheet or wire by either hot or cold working, and the wrought product so produced has been fabricated.

Each of these metals has special properties which make it particularly suitable for some application. Thus, titanium, combining strength and ductility with light weight and corrosion resistance, will become, particularly in alloy form, one of the widely used structural metals of the future. Zirconium can be expected to occupy a place as a corrosion resisting material particularly for handling hydrochloric acid. Molybdenum and its alloys will be used in the high temperature alloy field when suitable protective coatings are developed. Tantalum and tungsten are established in their respective fields and are fully commercialized. Columbium is well-known as a component of heat-resisting steels, but applications of the pure metal are still to come. The two other metals, vanadium and hafnium, are so new in ductile form that their possibilities have not been exploited.

In the following sections, each of these metals is considered individually. These sections will give the materials engineer an idea of their outstanding properties, methods of fabrication, and fields of application. The manual is confined in general to a discussion of the commercially pure metals.

There are other metals, such as cast iron and bismuth, which have been produced in ductile form during the past few years. A discussion of these metals has not been included because their characteristics are quite different from those of the group under consideration.

Titanium

With the exception of aluminum, iron and magnesium, titanium is the most abundant of the metals which have possibilities for use as constructional materials. Since adequate supplies are available in North America, the metal is highly regarded as a replacement for scarcer metals, and intensive development has been in progress for several years.

Although the commercial development is in a state of constant change, some evaluation of the present status is possible. The metal is produced at present by the iodide and Kroll processes, and rumors of other methods about to be commercialized are prevalent. The iodide process yields a purer material than the Kroll process but costs are higher and large scale production does not appear practical by this method unless considerable modification is possible. Thus, iodide titanium will probably always be regarded as a specialty product to be used where its superior ductility is advantageous or in research work to establish fundamental properties and constitutional diagrams of alloy systems.

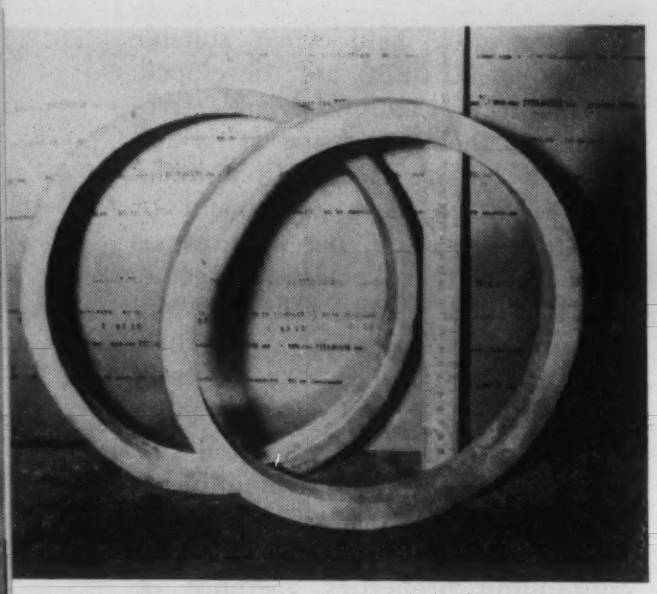
At present and for the immediate future, the bulk of the commercial metal will be produced by the Kroll process or its modifications. The titanium obtained by this process is in the form of sponge and must be melted or compacted by some other means to obtain a massive product for further working. A combination of hot and cold working methods is employed to produce the desired form after compacting. Titanium is available commercially as plate, sheet, rod, heavy forgings, drawn or extruded tubing, wire, and special shapes.

The commercial production of titanium is so new that standards of quality are still in preparation. ASTM specifications are almost ready for release as tentative standards. The specifications cover composition ranges and minimum mechanical properties for sheet and strip produced by both the Kroll and iodide processes. A tentative AMS standard has been distributed for approval.

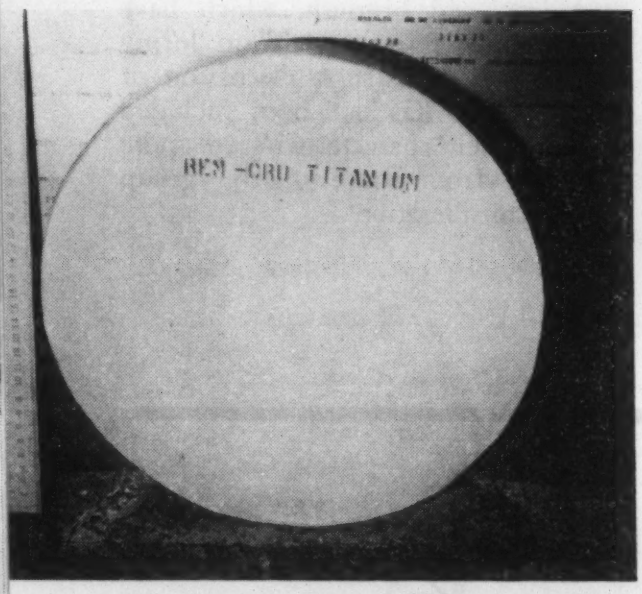
1200-lb ingots of commercially-pure titanium are in regular production for the Titanium Metals Corp.

Properties

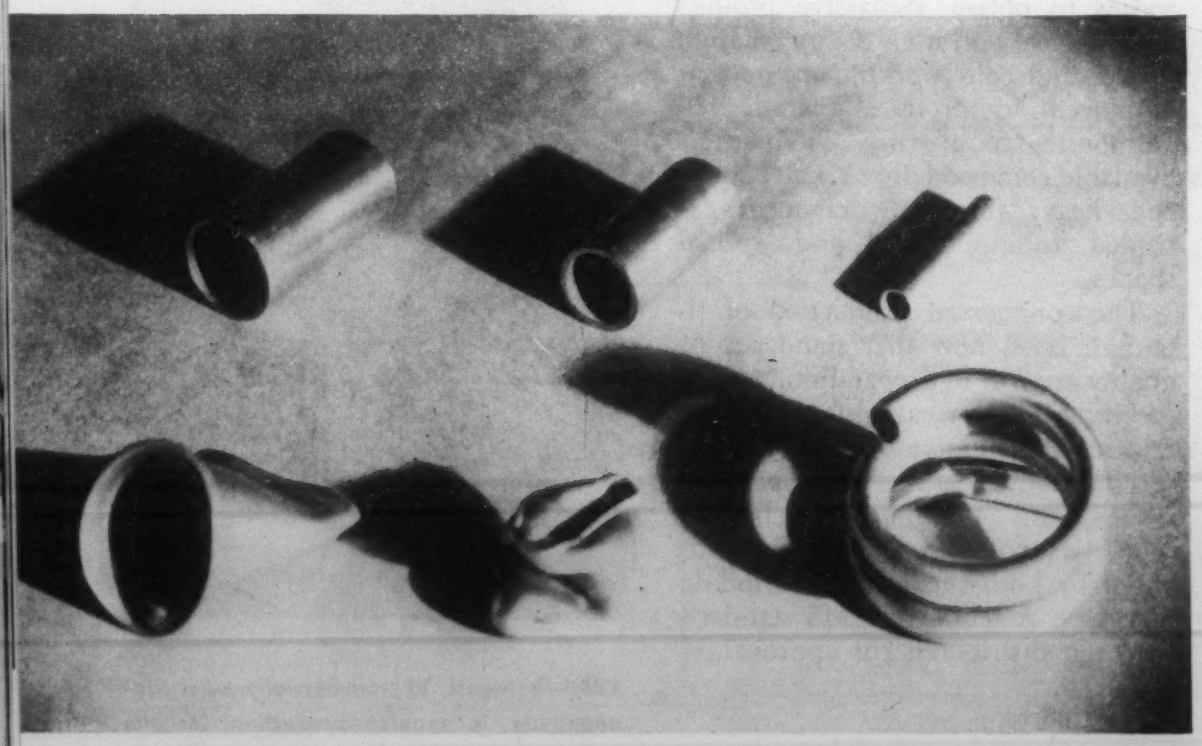
Some of the physical and mechani-



Forged rings, 26 in. O.D. by 22 in. I.D. by 3 in. thick, of Rem-Cru titanium alloy RC-130-B. In the background is a sheet of Rem-Cru commercial titanium.



400-lb forged disk of Rem-Cru titanium alloy RC-130-B. An annealed sheet of Rem-Cru commercial titanium furnishes the background.



Titanium tubing produced by Superior Tube can be flared, flattened and coiled readily.

cal properties of titanium are included in the accompanying tables. The melting point of the metal is higher than those of any of the present widely used constructional metals, while the density is intermediate between those of aluminum and the stainless steels. On the other hand, the modules of elasticity is only one-half that of the steels, and the coefficient of expansion is less than one-half that of the austenitic stainless steels. The electrical conductivities of titanium and the stainless steels are quite similar.

It should be emphasized that titanium is a reactive metal and considerable modification in its properties can be introduced during melting. Thus, carbon, oxygen and nitrogen can be dissolved in the metal, and all three, even in small quantities, have great effects on the properties. It has been stated by one authority that a few hundredths or tenths of a percent of nitrogen or oxygen alters the properties more drastically than steel is altered by carbon up to the eutectoid point. Permanent embrittlement will result from absorption of oxygen or nitrogen in sufficient quantities. At temperatures above 600 F, hydrogen can be absorbed in large quantities and may cause embrittlement. In contrast with embrittlement caused by oxygen or nitrogen, that caused by hydrogen can be removed by heating the metal in a vacuum. However, such treatment is probably not commercially feasible.

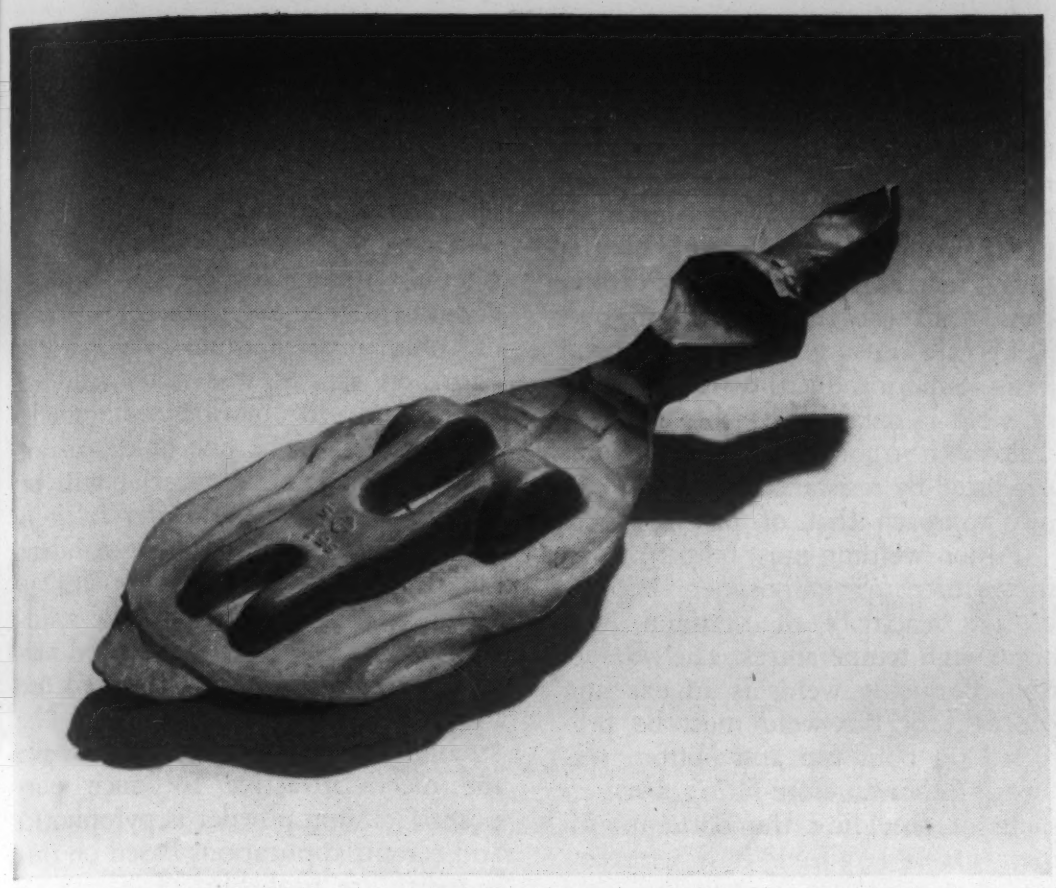
Titanium is resistant to oxidizing acids such as nitric and aqua regia, to dilute sulfuric and hydrochloric, and to most organic acids at room temperature. It is attacked by concentrations over 5% of hydrochloric acid, the rate increasing with the temperature. The metal is not resistant to hydrofluoric or to phosphoric acids at normal temperatures. It is resistant to dilute alkalies but is attacked by moderately concentrated solutions. In resistance to chlorides, titanium is outstanding. It is practically immune to attack by sea water, it resists boiling dilute solutions of many of the chlorides, and is unattacked by boiling saturated solutions of sodium chloride. Titanium is practically immune to stress-corrosion cracking in boiling saturated magnesium chloride and in hot 10% sodium hydroxide, two solutions which severely attack some of the steels.

Processing

Fabrication—Commercial titanium can be fabricated by bending, spinning, drawing, and similar operations. Annealed sheet up to 0.095 in. thick can be bent cold, parallel to the rolling direction, 180 deg on a diameter of 1T; perpendicular to the rolling direction a diameter of 1½ T is required. Half-hard material requires bend diameters of the order of 5T. Blanking, edge-rolling and other forming operations are possible on the commercial grade. For difficult forming operations, working at temperatures of 500 to 700 F increases the ease of forming, but most operations can be performed at ordinary temperatures.

Commercial titanium can be forged at temperatures of 1500 to 1700 F using regular production equipment. Light reductions should be employed to prevent cracking. Higher temperatures should not be used because of the danger of gas absorption, while difficulties in forming increase as the temperature falls below 1500 F, although the ductility is usually improved by finishing at 1300 F if the equipment is rugged enough to work the material at that temperature. Small reductions have been made by cold swaging but cracking can result from such a practice. Swaging can be performed quite readily if the bars are heated to 400 to 500 F.

Low carbon-oxygen-nitrogen titanium can be deep drawn as readily as stainless steel or nickel. However, titanium requires a greater draw-ring radius and hold-down pressure than the other metals mentioned. Lower



Titanium alloy forging produced by the Mallory-Sharon Titanium Corp.

press speeds also contribute to satisfactory results. The galling and seizing characteristics of titanium are troublesome, and suitable lubrication is essential in many operations. Metallic, solid resinous and molybdenum sulfide type lubricants have been used to counteract this tendency. Another expedient is the intentional oxidation of the surface of the material to prevent metal-to-metal contact. This procedure can be somewhat dangerous because of the possibility of embrittling the metal if it is done at high temperatures. Low temperature oxidation by a proprietary surface treatment can be done safely.

Machinability—Titanium resembles stainless steel in that both materials work harden rapidly and a tough springy chip is produced in turning. There is considerable difference of opinion concerning the relative machinability of these materials. Thus, some authorities state that titanium is more difficult to machine than stainless steel, while others maintain that titanium is more readily machinable than stainless and that the ease of machining increases with the purity. Suitable methods are still in the development stage but some suggestions are possible.

Recent production reports indicate that tungsten carbide tools will be widely used. These recommendations are diametrically opposed to those made a short time ago—another indication that there is still a lot to be learned on the subject. Current recommendations call for a long lead-angle tool for roughing cuts and a tool similar to those used in machining 18:8 stainless steel for finishing cuts. Cutting fluids and coolants do not appear to be critical. Some organizations are using the same lubricants they employ in machining other metals in their shops. Soap-base lubricants and mixtures of carbon tetrachloride with sulfur-base oils are also being used. At present it is the general opinion that milling with high-speed steel tools is preferable to milling with carbide tools. Speeds of 45 to 60 ft per min have been recommended for roughing cuts, with an increase to about 70 ft per min for fine cuts. In all machining operations a sharp tool is essential because a dull tool glazes the work, making further machining difficult.

Titanium is difficult to saw, particularly in heavy sections, and a heavy positive cut is usually desirable. Recently it has been found that satisfactory sawing can be accomplished with a number of machine saws if the work is flooded with a soluble oil and water coolant during the operation. Wet abrasive cut-off wheels are also satisfactory. Friction sawing, diamond sawing and flame-cutting have been used in a number of organizations. The latter is a rapid method of cutting, but the resulting surfaces are hard and introduce difficulties in subsequent machining operations.

Drilling and tapping are difficult because of the tendency of the metal to weld to the tool and the formation of a long curling chip. For satisfactory results the tools must be sharp and it is necessary that the feed not be disengaged while the tool is moving in contact with the work. The most promising procedure which has been developed is eccentric drilling using high-cobalt drills with notched lips. Slow speeds with feeds double those usually employed in drilling stainless steels are desirable.

Grinding—Because of the extremely high rate of wear of the wheel, titanium is a difficult metal to grind. Present indications are that, for surface grinding, best results are obtained with alumina wheels and low wheel speeds of 2000 to 3000 sfpm (apparently the key to successful grinding). Grinding should be done wet. It must be emphasized that these recommendations are tentative and apply only to surface grinding.

Heat Treatment—The crystal structure of titanium changes at 1625 F from hexagonal close-packed (the room temperature modification) to body-centered cubic. Slight hardening effects associated with this structural change have been reported for quenched material. Probably the only practical use which can be made of the transformation in commercially pure material is to produce a random grain structure after working below the transformation temperature in cases where this is desirable.

In alloys, however, transformation hardening effects will be really significant in the future. Commercially pure titanium can be annealed satisfactorily by heating in air at 1200 to 1300 F for periods of time depending on the thickness. Strain hardening can be removed by heating for 10 to 15 min in this temperature range. The relatively brief time required for annealing thin sheet at 1200 F makes it possible to anneal such sheet in air with little danger of embrittlement. If the heating is prolonged, a brittle surface layer will be formed. Titanium can be stress-relief annealed at temperatures above 600 F.

Cleaning and Finishing—Conventional degreasing methods can be employed for cleaning titanium. Light discoloration can be removed by immersion of the part in a pickling solution composed of 2% hydrofluoric acid and 10% nitric acid by volume. However, this solution will not remove the scale formed on annealing titanium in air. Removal of this scale can be accomplished by sodium hydride descaling or by the

Virgo or caustic bath currently being used by one organization. Authorities differ on the possibilities that this practice will embrittle the metal. If a bright finish is desired after the descaling treatment, the material can be dipped into the hydrofluoric nitric solution mentioned above. An alternate method of removing the heavy scale resulting from air annealing is sand blasting followed by pickling in the solution mentioned above.

Joining—Titanium can be welded to itself by resistance or inert-arc methods, but welding procedures for joining the metal to other constructional materials have not been developed. However, titanium can be brazed to dissimilar metals using titanium-copper or manganese-nickel alloys as the brazing materials. Soldering methods have not been developed.

For the production of satisfactory welds, the oxide scale formed during air-annealing must be removed by methods such as those discussed previously. Spot welds do not appear to be affected by the oxide coating, which is formed on titanium at room temperature. The spot and seam resistance welding of titanium is readily accomplished, and the conditions for producing satisfactory welds are not particularly critical. However, excessive penetration is characteristic of titanium spot welds, and conditions must be selected to limit the penetration since the welds are less ductile than the base metal. Weld brittleness increases with the carbon content of the titanium. Flash butt welds are in use on a production basis. Superior ductility in this type of weld is obtained by shielding the weld with argon. Strengths of welds produced by resistance welding methods approach that of parent metal.

Fusion welding must be performed in an inert gas atmosphere because of the reactivity of titanium with air at high temperatures. The production of ductile welds is an exacting process, for the weld must be protected on both top and bottom surfaces. Either a close-fitting back-up plate or shielding the bottom with inert gas is required. It is necessary also that metal adjacent to the weld which reaches a temperature of 1200 F be protected.

Applications

Commercial titanium is in use for corrosion resistant equipment in the chemical process industries. Currently, large installations are in construction for handling 22% sulfuric acid at high pressure and temperature and for handling concentrated ferrous chloride solutions. A pharmaceutical producer has incorporated titanium tubing into certain process equipment. The exceptional resistance of commercial titanium to salt-water corrosion assures it a wide field of application in marine equipment. This appears to be one of the major fields in which the material will be used in the future. In aircraft, it is employed for fire-walls, redundent bulkheads and stiffeners with a weight saving of 40% over the stainless steel replaced. The unalloyed material will probably have limited use in structural applications since the strength is not great enough to make the metal attractive for such purpose. Titanium powder is pyrophoric, and certain applications based on this property are probable.

However, the major use of titanium in the future will be in the form of alloys, particularly for structural applications in aircraft. These alloys can be expected to replace stainless steel and aluminum alloys to a large extent.

Zirconium

Zirconium is not a rare metal, being more plentiful in the earth than such common metals as copper, nickel and lead. It has always been found in combination with hafnium, which has very similar properties making separation difficult. Zirconium is in the stage of development reached by titanium several years ago. It is in production by both the iodide and Kroll processes. The commercial metal usually contains from 0.5 to 3% hafnium, depending on the source of the ore. Most commercial zirconium is thus actually a hafnium-zirconium alloy. A special grade produced by the iodide process after removing hafnium by chemical means contains less than 0.1% hafnium.

For most purposes, the presence of hafnium is not detrimental. The high-hafnium metal is slightly less ductile than the low hafnium material and somewhat less resistant to corrosion. However, carbon, oxygen and nitrogen have much greater effects on the properties of zirconium than hafnium. Commercial metal produced by the iodide process contains less oxygen and nitrogen, normally, than that produced by the Kroll process, with the result that iodide metal is softer and more ductile. Iodide zirconium is obtained in the form of crystal bar while Kroll zirconium is produced in sponge form. Crystal bar is sufficiently ductile to be cold worked directly into sheet or wire, or it can be melted and cast into a suitable shape for working. Kroll zirconium is obtained in a massive form usually by melting. Working into sheet, rod, tubing and shapes is performed by methods similar to those used for working titanium.

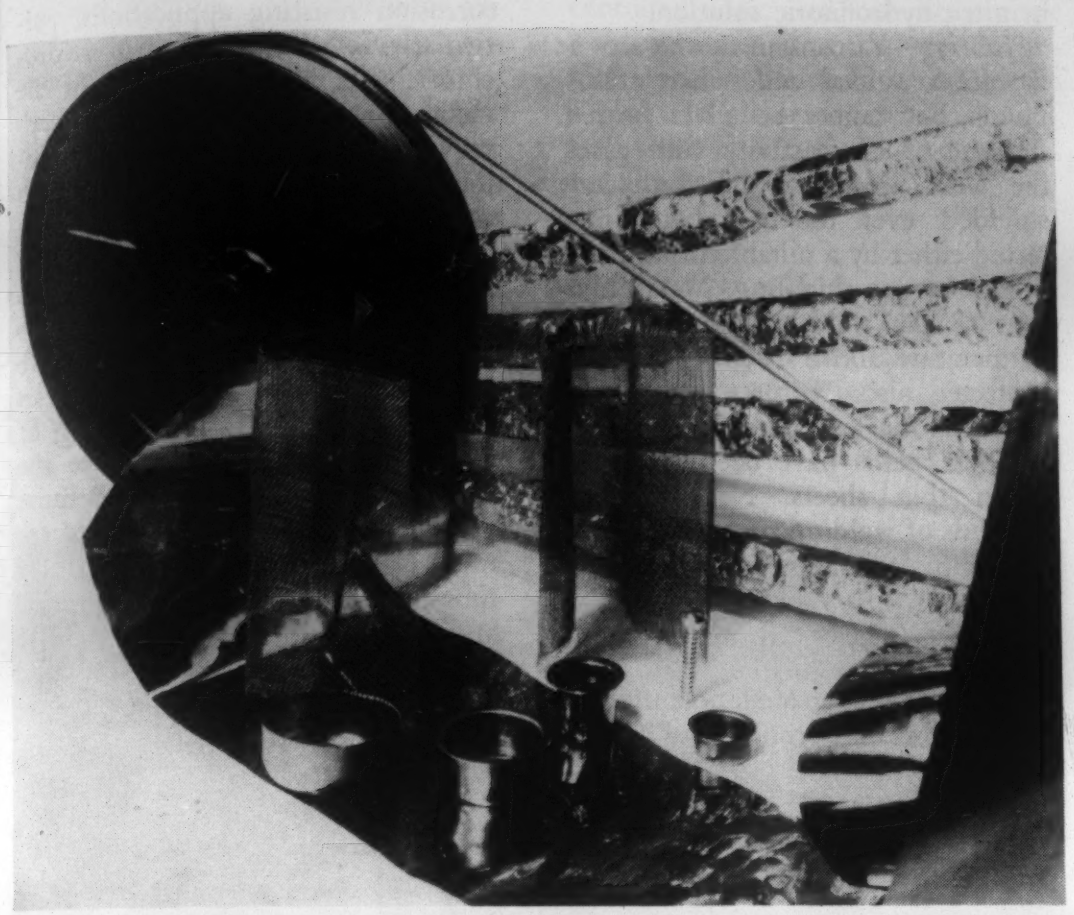
Properties

Some of the properties of zirconium are given in the accompanying tables. The density of zirconium is intermediate between titanium and iron. The thermal expansion and electrical resistivities are comparable to that of type 410 stainless steel.

One of the most important properties which does not appear in the tables is its reactivity with gases. Zirconium combines readily with all but the noble gases, and this fact underlies much of the difficulty in handling the metal. Thus, oxygen absorbed by zirconium goes into solid solution and, in sufficient quantities, makes the metal permanently brittle.

The strength of commercial zirconium approaches that of mild steel and the rate of loss of strength with rising temperature is not particularly rapid below 900 F. At low temperatures, the metal retains its strength and ductility down to —360 F.

At room temperature zirconium is resistant to attack by most organic acids, dilute sulfuric acid, nitric acid



Iodide zirconium produced by the Foote Mineral Co. can be worked into sheet, rod and wire, and fabricated into various parts.

in all concentrations, and the alkalies. Its resistance to hot and cold, dilute and concentrated hydrochloric acid is outstanding, approaching that of tantalum. The metal is not resistant to aqua regia or to hot concentrated sulfuric acid. The resistance of zirconium to chlorides is not as good as that of titanium. Low-hafnium zirconium is somewhat more resistant to corrosion than the normal commercial material. Thus, the former is resistant to fuming nitric acid while the latter is only moderately resistant. The corrosion resistance of zirconium is lowered also by the presence of carbon, oxygen and nitrogen, the effects of these impurities being more pronounced than that of hafnium.

Processing

Fabrication—The methods of fabricating zirconium are essentially the same as those employed for titanium. The crystal structure of these metals is similar to that of magnesium, and they are less easily worked than metals having structures like iron or copper. Workability can be increased by raising the temperature to about 400 F. The fabricating properties depend to some extent on the method of preparation of the metal. Iodide zirconium containing less oxygen and nitrogen than Kroll zirconium is more readily worked. Thus, iodide zirconium can be drawn to fine wire or rolled to thin sheet with little intermediate annealing.

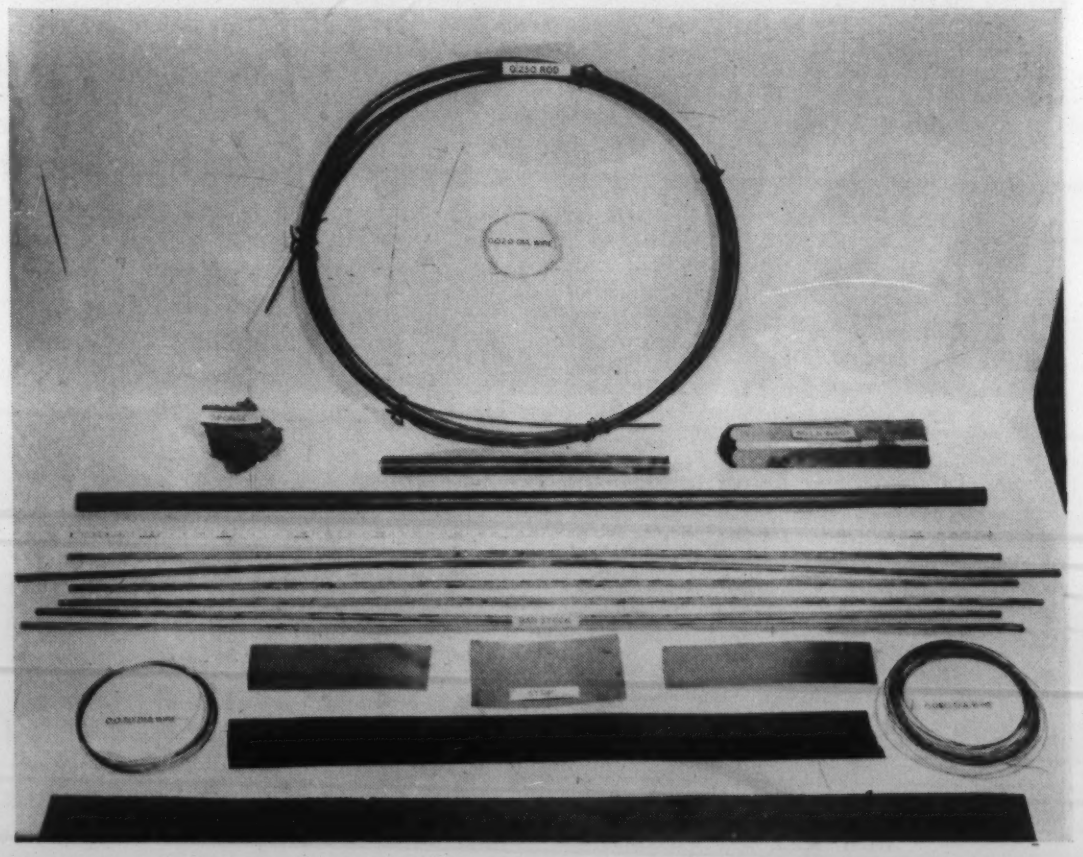
Zirconium is superior to magnesium in bending, deep-drawing, and forming operations at room temperature. Olsen cup tests indicate that annealed high purity zirconium can be deep drawn as readily as stainless steel or nickel although a greater draw-ring radius is required for satisfactory work. Zirconium can be hot forged, providing light blows of the hammer are used to prevent cracking, and can be swaged at about 1200 F. Iodide zirconium has been hot extruded, experimentally.

Galling and seizing are troublesome in drawing and machining operations. These undesirable properties can be minimized by purposely oxidizing the surface, although such an operation, if performed by heating at high temperature in air, must be carried out carefully to avoid embrittling the metal. A number of metallic, solid resinous, and heavy-duty molybdenum sulfide type lubricants have been developed which are satisfactory for use with zirconium.

Machinability — Machinability resembles that of titanium. Authorities differ on the ease of cutting these two metals. Some say they are more readily machined than stainless steel while others think that stainless is more readily machined. In general, the practices followed in machining titanium can be employed for zirconium.

Heat Treatment — Zirconium changes in crystal structure from hexagonal close-packed (the room temperature modification) to body-centered cubic at 1580 F. Quenching from above this temperature results in slight hardening of the metal—an indication that alloys may be devel-

The workability of Kroll zirconium is indicated by this selection of shapes produced by the Titanium Alloy Manufacturing Div.



oped which can be hardened by quenching. Zirconium can be stress relief annealed by heating at temperatures above 500 F and completely recrystallized by heating for an hour at 1550 F, or at higher temperatures for shorter periods. Heavy sections can be annealed in air, but light sections should be annealed in an inert atmosphere or in a vacuum to avoid embrittlement of the metal.

Cleaning and Finishing—Degreasing can be done by the usual methods in conventional equipment. Light surface discoloration can be removed by pickling in the nitric-hydrofluoric solution recommended for cleaning titanium. The heavy scale resulting from air annealing can be removed by sodium hydride descaling or by sand blasting. In either case, if a bright finish is desired, metal can be dipped in nitric-hydrofluoric solution.

Joining—Zirconium can be arc- or flash-butt welded under inert atmospheres but cannot be silver brazed. Because of its reactivity with gases, the weld area must be completely shielded, even the back being protected either by a suitable metal backing or by gas shielding. Metal adjacent to the weld, which reaches a temperature above 1200 F, must be protected also. If these precautions are taken the welds are ductile. Inert arc butt welds have been made between thin sheets. No successful methods of welding zirconium to dissimilar metals have been reported.

Applications

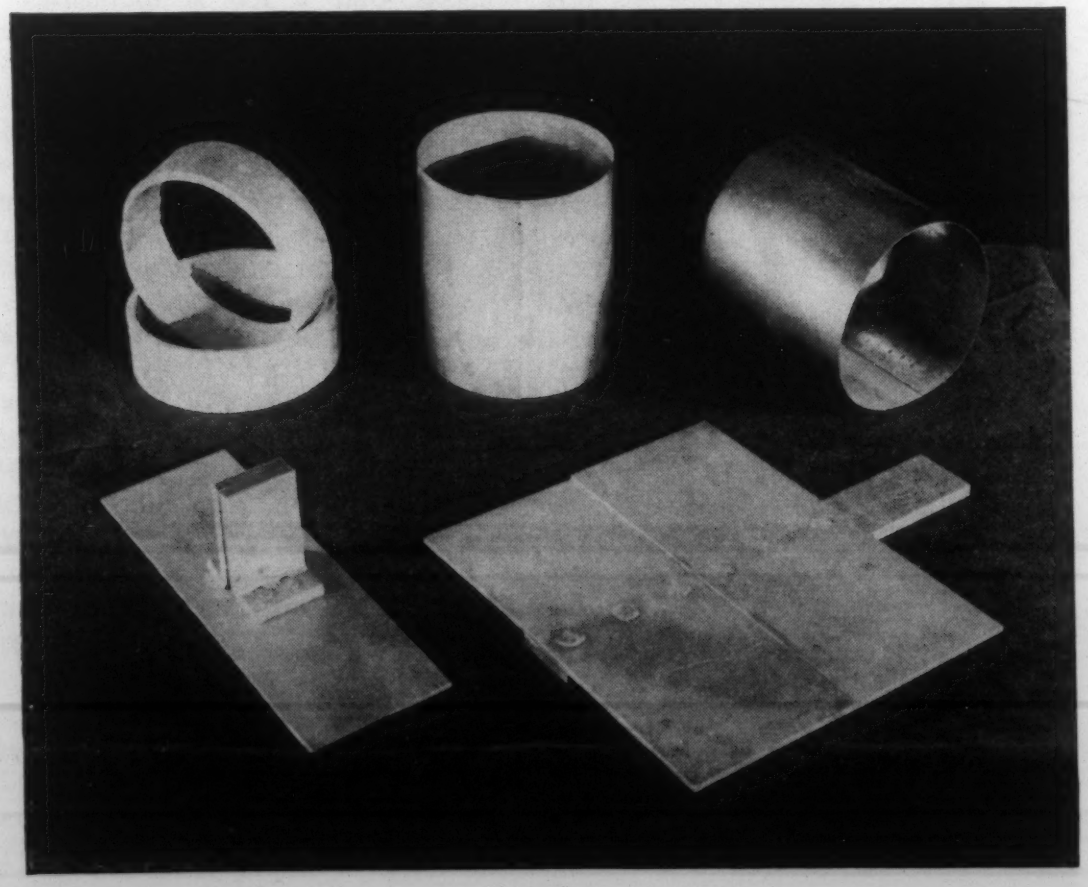
Probably the greatest potential industrial use of zirconium will be in corrosion resisting applications, particularly for the handling of hydrochloric acid. At present, most of the metal is employed in the atomic energy program. The low-hafnium modification has a low thermal neutron absorption coefficient and has been used in structural parts in atomic piles. Alloys using zirconium as a base are in experimental stages, particularly those designed to improve the elevated temperature properties of the material. Most promising of those investigated thus far are the alloys containing aluminum. Because of its great affinity for gases, zirconium is used as a getter in electronic tubes, in photoflash bulbs as a primer, and in fluorescent lamps to increase the efficiency. Its corrosion resistance and non-toxic nature make it potentially valuable in surgery.

Molybdenum

Molybdenum is relatively abundant not only in the United States but in many other parts of the world. The deposits in the United States are large enough to make the metal appealing from the strategic point of view. This fact, coupled with its high melting point, makes molybdenum attractive as a possible material for severe service at high temperatures. Although the metal has desirable mechanical and thermal properties, it oxidizes rapidly at elevated temperatures and means must be developed to protect the surface before the full potentialities of molybdenum can be realized.

The metal is separated from its ores and purified by chemical methods, the pure material being produced in powder form. Massive molybdenum is obtained either by powder metallurgical methods or by casting in an inert atmosphere or a vacuum. The sintered or cast shapes are broken down hot by rolling or forging. Bar, rod and sheet are produced in the desired sizes by a combination of hot and cold rolling. Seamless tubing is formed by extrusion, followed by drawing to size.

The workability of molybdenum is demonstrated by these pieces fabricated by welding and riveting at Westinghouse. At top are rings and cylinders for high-frequency equipment, at bottom are electrodes for glass furnaces.



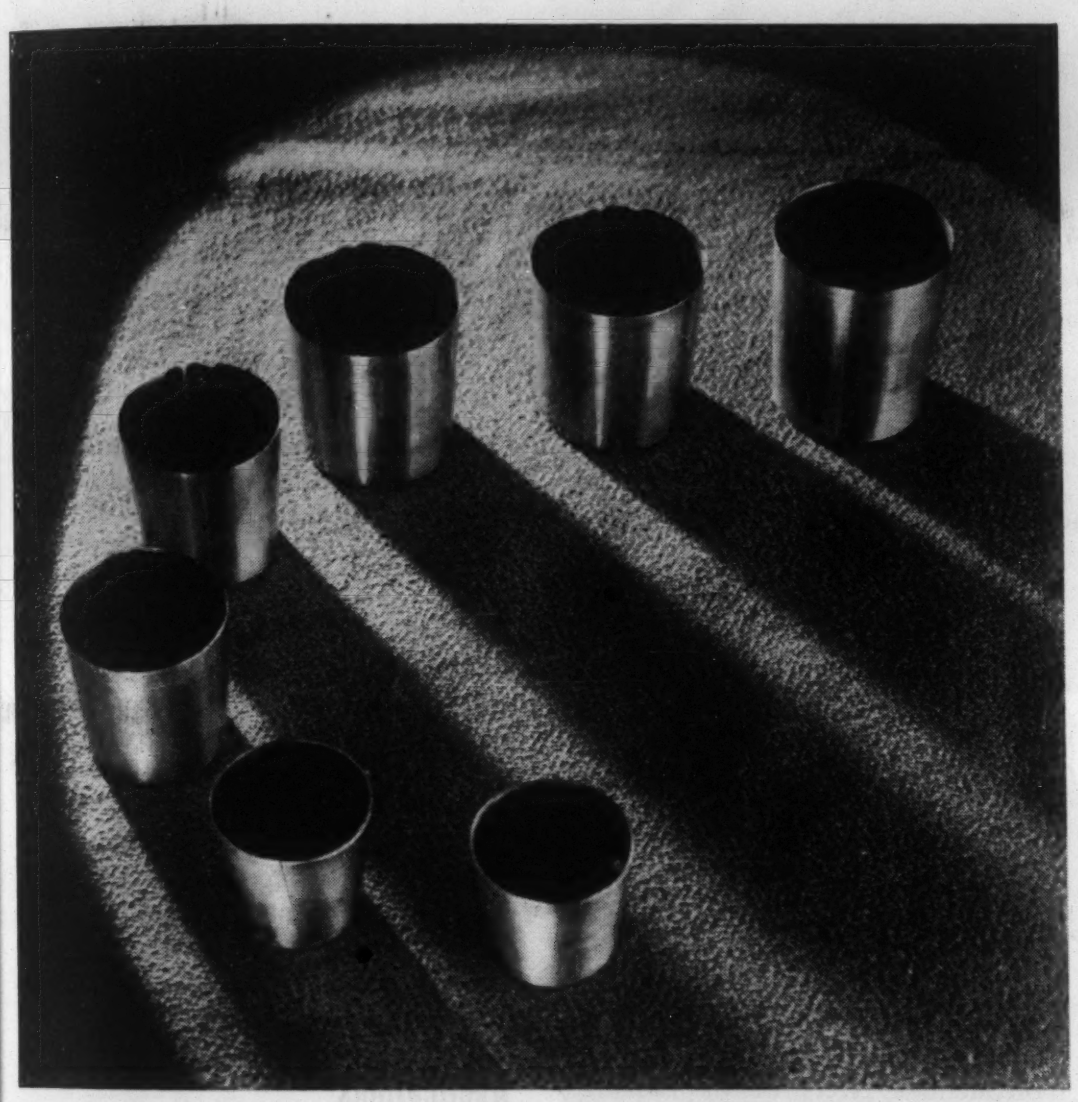
Properties

The density of molybdenum is roughly half that of tungsten, while the melting point is almost twice that of mild steel. The thermal conductivity is less than half that of copper, but is considerably higher than those of iron and nickel. The coefficient of expansion is about one-half that of steel. Although the electrical conductivity is only a third of that of copper, molybdenum is a better conductor than nickel, phosphor bronze or steel.

Among the properties not included in the table, the most important in the development of molybdenum as a useful high temperature material is

surface stability. Molybdenum oxidizes rapidly at high temperatures, while the oxide formed evaporates at appreciable rates above 1400 F, and thus offers no protection to the underlying metal. To obtain economical life, some means of protecting the surface must be developed. Cladding, electroplating, siliconizing and ceramic coating have given promise toward accomplishing this objective. Siliconizing is being commercialized while the other methods are still in the experimental stage of development. The room temperature ductility of molybdenum is relatively good and the metal is quite ductile at high temperatures. The load carrying ability of molybdenum above 1800 F is greater than that of the commercial heat-resisting alloys, and preliminary work indicates that the creep properties are good.

In general, molybdenum is less resistant to corrosion than tungsten. At room temperature the metal tarnishes in moist air and is attacked slightly by water. Molybdenum is moderately resistant to attack by sulfuric, hydrochloric and hydrofluoric acids and by the alkalies. It is passivated by concentrated nitric acid, but dilute nitric or a mixture of nitric and hydrofluoric acids dissolves molybdenum rapidly. In air or dry oxygen, oxidation starts at 575 F. Molybdenum is not attacked by hydrogen.



Molybdenum sheet is spun readily into cylinders. (Westinghouse Electric Corp.)

Processing

Fabrication—Most procedures in forming molybdenum are conventional. Although the metal is more ductile than tungsten at ordinary temperatures, forming or bending in a chilled condition will result in cracking. The metal should never be worked at temperatures below 70 F.

Sheet less than 0.020 in. thick can be formed readily at room temperature. To avoid cracking, sheet ranging from 0.020 to 0.040 in. in thickness should be worked at 200 to 325 F, while heavier sheet requires working temperatures of 900 to 1000 F. In punching or shearing, the working temperature should be raised progressively as the thickness is increased. Dies should be sharp to prevent laminations or cracking.

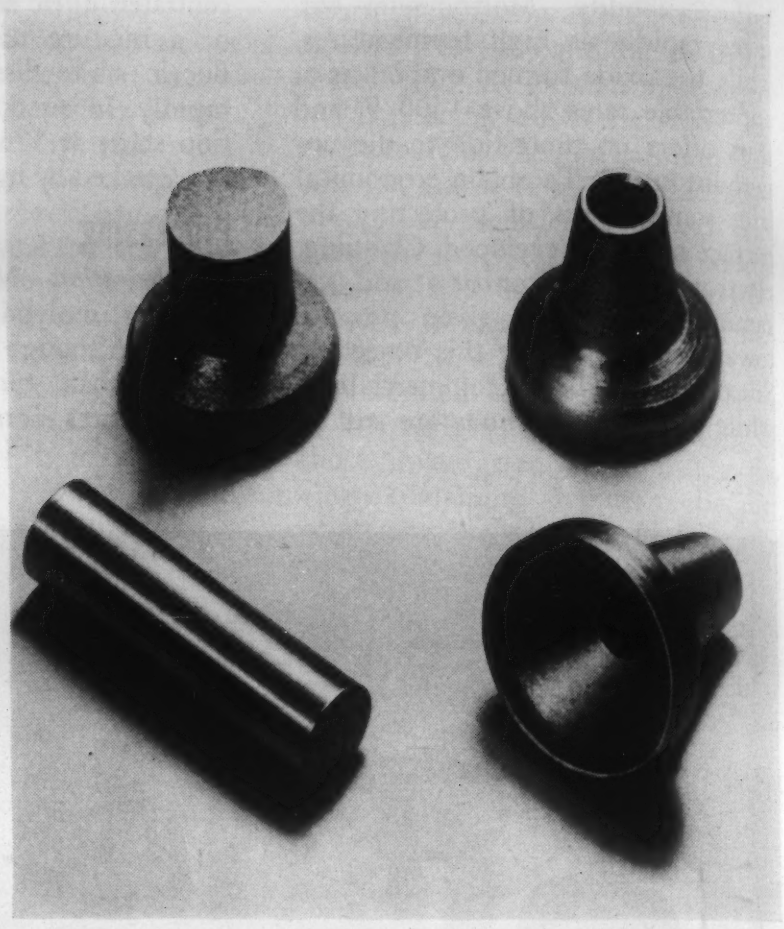
Molybdenum parts to be drawn should be designed for finishing in one operation if possible, and the diameter of the cup after drawing should be not less than 60% of the diameter of the blank. The possibility of cracking increases with each additional draw and the minimum number should be used. Aluminum bronze is suggested for die material. If steel dies are employed, abundant light oil should be used as the lubricant. Molybdenum can be spun by the customary procedures using aluminum bronze tools. In common with other operations on molybdenum, drawing and spinning should be done on heated material, excepting in the lightest gages.

In other than the light gages, molybdenum can be heated in air up to temperatures of 750 F without excessive oxidation if short times are employed. For higher temperature working, the metal should be heated in an atmosphere of hydrogen.

Machinability — In machinability, molybdenum resembles SAE 1040 steel heat treated to a hardness of 30 Rockwell C more nearly than any other material. It machines with the same crumbling chip which characterizes the steel. Tungsten carbide or high-speed steel tools can be used, the latter being preferred in many shops.

For turning, tools similar to those used for cast iron are satisfactory. Speeds up to 100 ft per min with a depth of cut of at least 0.005 in. are suggested. Sulfur base cutting oils can be used for both roughing and finishing cuts. Molybdenum has a tendency to chip during machining, and the work must be held rigidly to prevent this. Face milling is not generally recommended, although it can be accomplished with carbide-tipped tools. Molybdenum plates can be edge machined and, as a matter of fact, it is desirable to edge machine plates thicker than 0.050 in. rather than shearing to final dimensions. The molybdenum should be held between steel plates during this operation to avoid chipping. The metal can be drilled with high-speed steel drills although carbide drills are recommended. A sulfur-base cutting oil should be used. Threading and tapping are difficult. The thread depth should not be more than 50 to 60%, and rethreading should be avoided because of the tendency of the metal to chip. Molybdenum can be roll-threaded if both work and die are heated to 325 F. The metal can be ground by procedures which are satisfactory for cast iron.

Molybdenum deep-drawn cups and sheet are welded at Fansteel to produce anodes for electronic equipment.



Molybdenum rod (lower left) was hot forged at Fansteel into the section shown above (upper left) and the part (right) was finished by machining and drilling.

Heat Treatment—The function of the heat treatment of molybdenum is to relieve stresses. The temperature required depends on the previous history of the metal. For example, thin sheet can be stress-relief annealed by heating to 1830 F for 3 min. Time and temperature are critical. If either is exceeded, recrystallization and embrittlement will occur regardless of the type of heating or the atmosphere. On the other hand, heavier sections can be annealed at considerably higher temperatures without embrittlement. A number of organizations anneal to specified mechanical properties rather than at a definite temperature.

Cleaning and Finishing—Conventional methods of cleaning and degreasing can be used. Parts requiring chemical cleanliness can be cleaned by immersion in hot chromic acid solution. Parts to be resistance welded can be etched by immersion for 10 sec at 195 F in the following solution:

Sulfuric acid, conc...	5 gal
Chromic acid.....	375 gm
Hydrofluoric acid....	1 qt
Nitric acid, conc....	1/10 qt

Following the etching operation, the parts should be immersed in chromic acid solution to remove the blue oxide. Sand blasting is an alternate method of preparing parts for welding.

Electropolishing for bright finishes can be done in a chromic acid solution. Molybdenum parts can be "hydrogen fired" to reduce oxides and relieve stresses by heating in hydrogen or, if no further working is required, in dissociated ammonia followed by cooling in the same atmosphere.

Joining — Molybdenum parts are generally joined by riveting with molybdenum rivets or by brazing, although resistance welding methods are also applicable.

Thin sheets can be brazed with copper or silver brazing alloys using a spot or seam welder. No flux is necessary if the parts are properly cleaned. For applications at temperatures which exceed the melting points of these brazing materials, molybdenum can be brazed with tantalunt foil, the operation being done under water to prevent oxidation of the tantalum.

Molybdenum can be resistance welded by spot or projection welding methods. Spot welds of fair quality can be made if the two surfaces are etched or sand blasted. Careful control of the welding procedure is necessary. The welds are brittle at ordinary temperatures but ductility increases at temperatures above 200 F.

Although the resistance welding of small molybdenum parts produced from thin sheet has been commercialized for years, the welding of heavy sections is still in the development stage. The inert-gas arc welding process has also been used to join molybdenum, but the process requires special equipment and is quite critical.

Applications

Molybdenum is widely used for electrodes in the electric melting of glass. Such electrodes are produced from sheet as thick as 3/4 in. or bars up to 1 in. in dia. This is the major use of the metal in heavy sections at the present time. The metal is widely used for components in electronic tubes and to support the tungsten filaments in incandescent lamps. The metal is employed as the heating element in high temperature electric furnaces, the wire or ribbon being protected from oxidation with a hydrogen atmosphere. Other uses include electrodes for spark gaps, cooling coils and electrical contacts. Molybdenum is a component of many alloy steels and several of the new high temperature alloys.

Tungsten

Although tungsten deposits are distributed widely throughout the world, the ores are much less abundant than molybdenum ores. The metal is separated from its ores and purified by chemical means, and is obtained in powder form by the reduction of the oxide with hydrogen. Massive tungsten is prepared by powder metallurgical methods. The sintered bar so produced is obtained in the desired form by forging, rolling into sheet or plate, swaging to rod, and drawing to wire. Most of the operations are done hot.

Properties

Tungsten is one of the heaviest of the metals, while its melting point is the highest of all. The thermal conductivity is less than half that of copper but is greater than that of nickel or iron. At room temperature, the coefficient of expansion of tungsten is approximately one-quarter that of copper. Some of the mechanical properties of the metal are given in the accompanying table. The tensile strength of tungsten wire increases markedly with reduction in size without a corresponding increase in hardness. Thus, the strength is more than doubled by swaging from 0.25 to 0.10 in., while the hardness increases only three numbers on the Rockwell C scale.

At temperatures up to 212 F, tungsten is resistant to attack by most acids and alkalies. It is rapidly destroyed by a mixture of hydrofluoric and nitric acids at room temperature and by aqua regia at 212 F. Untarnished by air at ordinary temperatures, tungsten begins to oxidize at appreciable rates at 750 F. The metal is not attacked by hydrogen.

Processing

Fabrication—Compared with the other metals in this group, the ductility of tungsten is low. It is a rather brittle metal at room temperature, and the danger of cracking or breaking must be considered. Only simple forming operations on wire below 0.030-in. dia should be performed cold. General forming operations can be done on sheet up to 0.010-in. thickness and wire up to 0.010-in.

Hot-rolling tungsten in the plant of P. R. Mallory.

Tungsten electrodes in sizes ranging from 0.040- to 1/4-in. dia are used to sustain the arc in inert and atomic hydrogen welding. (Fansteel)

Inspection of finished tungsten parts at Fansteel.

dia at 200 F. Progressive increases in temperature are required as the sheet thickness or wire diameter are increased. Material heavier than 0.040 in. should be heated to 2100 to 3000 F for forming. Fractures of the metal will be almost certain, if the proper forming temperatures are not employed. In bending, a radius of at least twice the thickness (or diameter) should be specified.

In blanking, punching or shearing, the material should be worked hot, with the temperature selected to suit the thickness. Tools must be sharp to avoid cracking the metal. Although tool steel dies can be used, carbide dies are preferred. Sheet thicker than 0.050 in. should be sheared to within 1/16 to 1/8 in. of the desired dimensions and edge-ground to size.

Tungsten is not readily forged. Swaging can be done on hot material with limited reductions in each operation and reheating between operations.

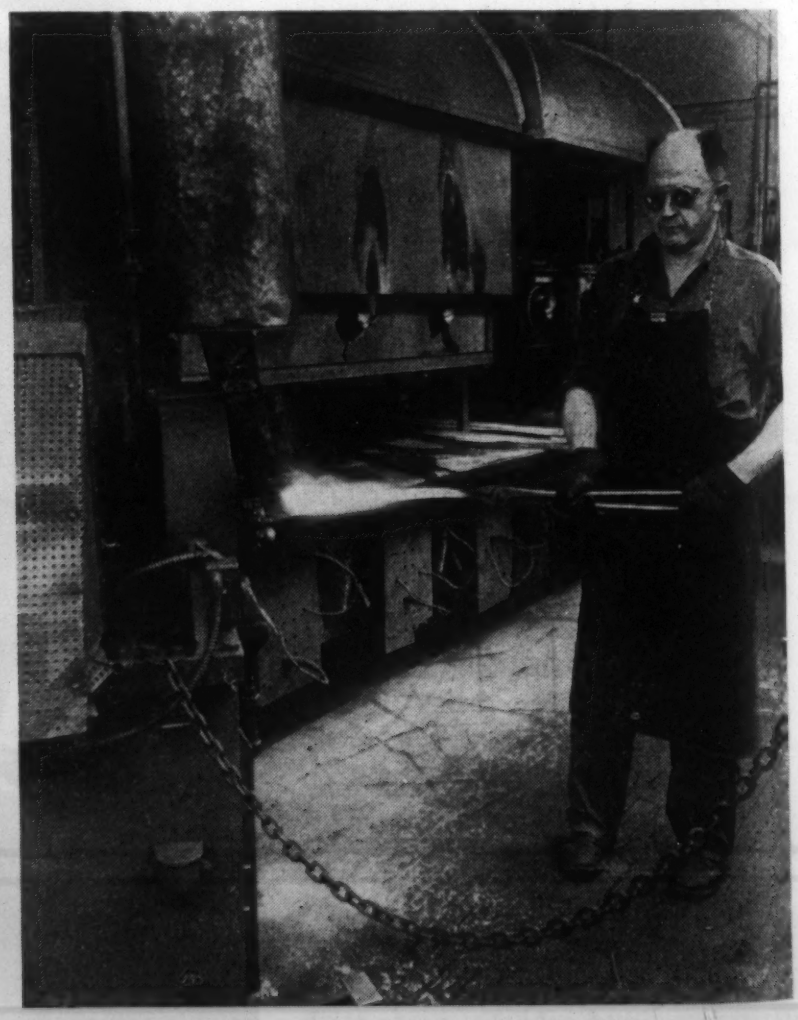
Grinding and Cutting—The machining of tungsten is difficult and is not recommended. Finishing and cutting operations should be performed by the use of abrasive wheels. In grinding, care must be exercised to avoid chipping or cracking. Constant movement of the work, light pressure and liberal application of the cooling media should be employed. Silicon carbide wheels are most satisfactory for all types of grinding. Attempts to cut rod or wire with shears almost always results in the formation of cracks which are difficult to remove by grinding.

Heat Treatment—Full annealing, involving recrystallization of the metal, embrittles tungsten, and the function of the annealing of this material is to relieve stresses and prevent cracking. Stress relief annealing of tungsten can be done at 1830 F for periods of 20 to 30 min, the time depending on the thickness of the material.

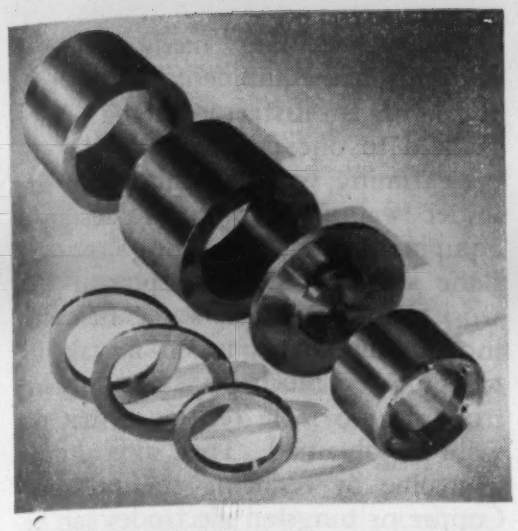
Cleaning and Finishing—Conventional methods can be used to degrease tungsten parts which have been formed cold or formed hot in a reducing atmosphere. If the parts have been heated in air, however, the oxide coating, which develops, might require removal. This can be accomplished by electrolytic caustic cleaning or by immersion of the parts in molten caustic soda for a few seconds, draining, cooling, and rinsing in hot running water. Since molten caustic soda attacks tungsten, the time of immersion should be held to the minimum necessary to remove the oxide. Molten caustic soda is a dangerous material and suitable safety precautions should be taken.

Parts can be "hydrogen fired" to reduce the oxide, obtain chemical cleanliness, and relieve stresses. The metal should be heated in hydrogen at 1470 to 1830 F for 10 to 30 min. Alternately, dissociated ammonia can be used, if no further forming is required. The parts must be cooled in the same protective atmosphere.

Heavy tungsten rod for electrical contacts, welding electrodes and glass-metal seals in heavy wattage incandescent lamps and electron tubes is ground in a centerless grinder at Sylvania.



First series of hot swages of sintered tungsten bar in a long series of hot-swaging and hot-drawing operations in the production of fine filamentary wires at Sylvania.



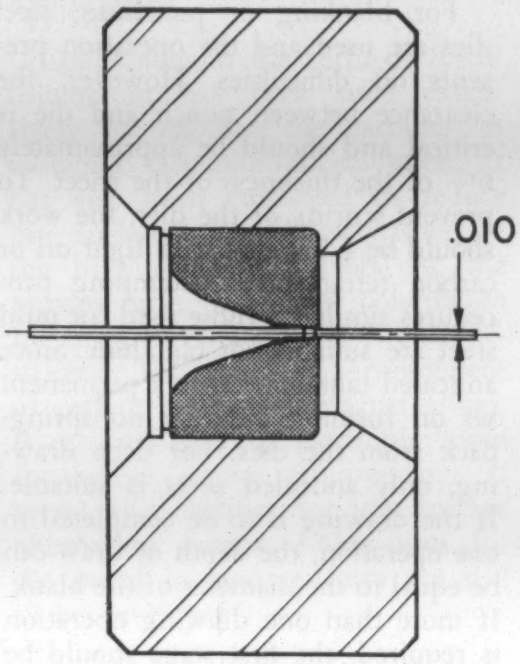
High density tungsten alloy parts produced by P. R. Mallory for gyroscope rotors, self-winding watches and similar applications where maximum weight in minimum space is required.

Tungsten can be polished electrolytically to obtain a bright finish using a 10% solution of sodium hydroxide.

Joining—Tungsten can be brazed to itself and some other metals using copper, nickel, or other high temperature brazing materials on conventional spot and seam welding machines. If the parts are cleaned thoroughly, no flux is required. For high temperature service, tungsten can be brazed with tantalum foil using a spot or seam welder. The work must be immersed in water to prevent oxidation of the tantalum. Torch brazing is not desirable because of the severe oxidation of the tungsten. Tungsten has been welded successfully to itself by inert-gas arc welding methods. However, the process is still in the developmental stage.

Applications

Tungsten is used for filaments in incandescent lamps, electronic parts and targets for x-ray tubes. In atomic-hydrogen or inert-gas arc welding, tungsten electrodes are used to maintain the arc. The metal is also used to face electrodes for some resistance welding operations. As an alloying element, tungsten is widely used in high-speed steels. A sintered tungsten alloy containing copper and nickel has a specific gravity of 16.5 and is used for balancing crank-shafts. Tungsten is resistant to attack by molten zinc and has been employed for pump parts in handling this material. The carbide is used for cutting tools, dies and wear resisting parts.



Cross-section sketch of a tungsten carbide die used for the drawing of tungsten wire for lamp filaments at Cleveland Wire Div. of General Electric.

Tantalum

Minerals containing tantalum also contain columbium, and the two metals have similar properties. They are separated with difficulty by chemical means. Tantalum is then obtained in powder form by electrolysis. The metal is highly reactive at high temperatures, but is obtained in massive form by powder metallurgical processes, or by arc-melting, followed by cold-rolling or drawing. Tantalum is available commercially in the form of sheet, rod, wire, tubing and fabricated parts.

Properties

Pure tantalum is quite ductile and its workability is similar to that of mild steel. Some of the properties of the metal are given in the table.

Tantalum is about twice as heavy as steel but resembles it in many of its properties. The strength, hardness, ductility and thermal conductivity of tantalum are comparable to those of mild steel. The electrical conductivity is somewhat lower while the coefficient of thermal expansion is only half that of steel. Tantalum is practically non-magnetic.

Tantalum is known most widely for its corrosion resistance, which resembles that of glass more nearly than that of other metals. At normal temperatures, the metal is inert toward practically all acids, with the exception of hydrofluoric, fuming sulfuric, and a mixture of hydrofluoric and nitric. However, it is much less resistant to alkalies and is corroded by salts which contain or hydrolize to strong alkalies. It is attacked also by fluorides. Tantalum is resistant to natural fresh water, sea water and acid mine waters, but may be attacked by highly alkaline boiler waters or condensate. At elevated temperatures, however, corrosion rates depend to a great extent on the temperature of the corroding medium. Tantalum is unattacked by wet or dry chlorine at normal temperatures but reacts with the gas at 350 F. At higher temperatures it reacts with other gases, and at extremely high temperatures it combines with most of the elements.

Because of its high melting point and excellent resistance to corrosion, tantalum is frequently considered suitable for elevated temperature service. This is not the case. Tantalum is not resistant to air at elevated temperatures, while all but the noble gases react with the metal at high temperatures. On the other hand, heating at high temperatures in a vacuum does not embrittle the metal, a phenomenon which occurs when tungsten or molybdenum are treated similarly. The application of tantalum at temperatures above 500 to 600 F is not recommended, except in electronic tubes where its reactivity with stray gases becomes a distinct asset.

Processing

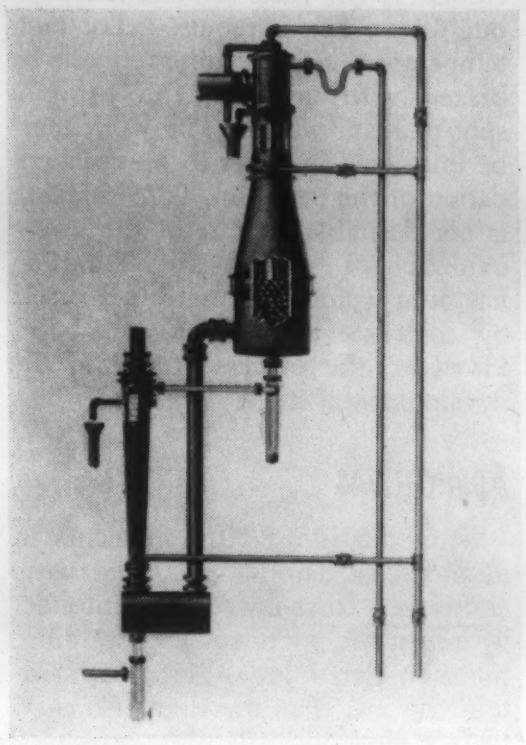
Fabrication—All forming operations on tantalum are done cold, and the metal can be fabricated into complicated form readily. Heating of the metal does not increase its ductility and may actually embrittle it because of the absorption of gas. Generally, the thickness of sheet for forming

ranges from 0.004 to 0.015 in. and the following remarks apply to material within this range.

For blanking or punching, steel dies are used and the operation presents no difficulties. However, the clearance between punch and die is critical and should be approximately 6% of the thickness of the sheet. To prevent scoring of the dies, the work should be lubricated with light oil or carbon tetrachloride. Stamping procedures similar to those used for mild steel are suitable for tantalum. Since annealed tantalum takes a permanent set on forming, there is no springback from the dies. For deep drawing, only annealed sheet is suitable. If the drawing is to be completed in one operation, the depth of draw can be equal to the diameter of the blank. If more than one drawing operation is required, the first stage should be limited to a depth of 40 to 50% of the diameter of the blank. Simple, straight-side, flat-bottom cups are produced with less difficulty than cones or domes. The dies should be lubricated with sulfonated tallow. Spinning is performed conventionally and yellow soap is suitable for lubrication.

Strong ductile welds are made in tantalum sheet by a special adaptation of the inert gas method at Fansteel.

Machinability — Tantalum resembles stainless steel in its tendency to gall or seize while being machined. In lathe operations, high-speed steel tools with high cutting speeds have proved satisfactory for machining tantalum, while tungsten carbide and nonferrous alloy cutting tools have not proved useful because of the tendency of tantalum to weld to the cutting edge. Tools with angles similar to those used for annealed copper can be employed. A minimum surface speed of 100 ft per min is required in turning operations since



Hydrochloric acid absorption plants designed by Fansteel employ water-cooled tantalum surfaces to remove the heat of absorption.

slower speeds cause tearing of the metal. A satisfactory cutting medium is carbon tetrachloride, and the work must be well flooded at all times. Milling, drilling, threading and tapping tantalum require the same general procedures. Conventional roughing cuts followed by light finishing cuts do not produce finishes as satisfactory as those obtained by using sharp tools and light feeds and finishing the work in one operation.

Grinding of annealed tantalum is almost impossible, but hardened tantalum can be ground with silicon carbide wheels. However, the operation should be avoided if possible.

Heat Treatment—Tantalum can be annealed at temperatures above 1950 F in a high vacuum. Specialized equipment is required.

Cleaning—Cleaning can be done by conventional methods, although hot caustic solutions are not suitable as they attack the metal. Parts can be rendered chemically clean by immersion in a hot chromic acid cleaning solution similar to that used in cleaning glass. If the parts have been shot-blasted, they should be immersed in hot hydrochloric acid to dissolve iron particles before cleaning in the chromic acid solution. After cleaning, the parts should be thoroughly rinsed, and dried in a stream of warm, dust-free air. Hydrogen-firing cannot be used to clean tantalum parts because the metal will be embrittled by such treatment.

Welding—Tantalum can be welded to itself and some other metals by resistance welding methods using conventional equipment. Spot welding in air is satisfactory if the timing is held to one cycle. For 3- to 10-cycle timing, welding must be done under water. In properly designed equipment, seam welding can be done without an interrupter if the work is submerged in water. In welding tantalum, a common mistake is to apply too much pressure, thus introducing so little resistance that no weld is obtained. This difficulty is overcome by reducing the pressure. Copper or tungsten electrodes can be used for resistance welding. Properly made welds are ductile and as strong as the base metal.

Tantalum can be welded also to itself by an adaptation of the inert gas arc-welding process using highly purified gas and special controls and fixtures. The metal cannot be torch welded.

Applications

The principal applications of tantalum are based on its corrosion resistance. Tantalum heat exchangers, condensers, coils and bayonet heaters are used for the processing of such corrosive materials as chlorine, hydrochloric acid, chlorides and nitric acid. Tantalum is used also for the production of hydrochloric acid by absorption of hydrogen chloride from synthetic or by-product gas. Tantalum jets are employed for the introduction of live steam, chlorine and other gases into liquids. Since the metal is not attacked by body fluids, it is widely used as implants and sutures in surgery. The metal is used also in various electronic applications, particularly for transmitting tubes operated at high temperatures. An unusual application is the development of a gage for measuring the depth of liquid helium, based on the fact that tantalum becomes a super conductor at –454 F. A wire mounted vertically in the tank has normal electric resistance above the liquid level and zero resistance below. The liquid level is determined by resistance measurements.

Columbium

Since columbium and tantalum have similar properties, much of the

discussion on tantalum applies equally to columbium. After separation from tantalum by chemical means, columbium is obtained in powder form by electrolysis. Powder metallurgical methods are used to obtain the metal in a form suitable for further working. Columbium is available commercially in the form of sheet, rod, wire, powder, and in fabricated parts.

Properties

Some of the physical and mechanical properties of columbium are included in the tables. The density of columbium is quite close to that of copper and roughly half that of tantalum. The strength and ductility resemble those of tantalum while the thermal expansion and electrical resistivity are slightly higher. Like tantalum, columbium is practically non-magnetic.

Although highly resistant to corrosion in comparison with most metals, columbium is less resistant than tantalum. At ordinary temperatures, columbium is practically unattacked by most of the organic and mineral acids but is considerably less resistant to the alkalies. However, hydrofluoric acid or a mixture of hydrofluoric and nitric acids dissolves the metal. At temperatures above 212 F, the resistance of columbium to attack by acids is considerably reduced. The metal is highly resistant to rural, marine and industrial atmospheres.

Columbium has a high affinity for oxygen, but the oxide film formed when the metal is heated is somewhat protective and limits the rate of penetration. At moderately elevated temperatures, oxygen has less effect on the ductility of columbium than air since nitrogen penetrates the metal while oxygen has only a surface effect at these temperatures. At high temperatures, columbium reacts with chlorine, bromine and iodine, and with practically all of the gases with the exception of the noble gases. This property makes it useful as a getter in electronic tubes.

Processing

Fabrication — Procedures for the fabrication of columbium are similar to those for tantalum. All forming operations must be performed cold. Columbium can be drawn, stamped and formed into complicated shapes. Since this metal, like tantalum, work-hardens at a low rate, reduction as high as 60% can be made in one operation. In deep-drawing, columbium is more resistant to tearing and slitting than most metals.

Machining—Columbium can be machined with tools similar to those used for machining steel. The use of carbon tetrachloride as a cutting fluid reduces the tendency of the metal to gall or tear during machining.

Heat Treating—Columbium can be annealed at temperatures above 1950 F in a high vacuum in specialized equipment.

Welding—Columbium can be welded to itself and to some other metals by resistance welding using procedures similar to those employed in welding tantalum. Arc welding is possible but is a difficult operation requiring special procedures. Gas welding is not suitable for the joining of columbium.

Applications

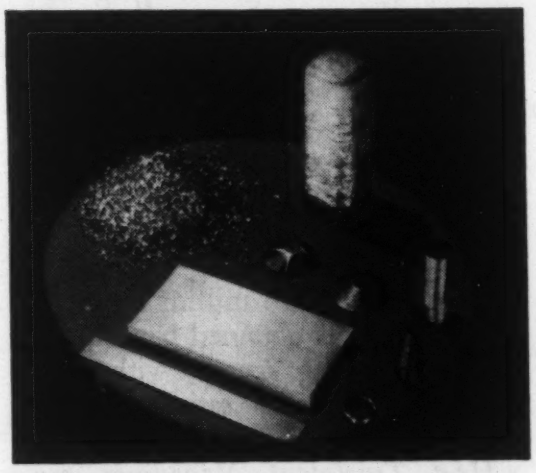
Columbium in the form of ferrocolumbium has been used extensively to stabilize the carbides in austenitic chromium-nickel steels. It has also been employed to reduce the air-hardening characteristics of the high chromium steels. At the present time, the use of columbium for such applications is highly restricted. The metal is a component of certain permanent magnet alloys. It is used also in electronic tubes for severe service requirements. It serves as a rectifier for low voltage alternating current. Other uses for the metal in massive form are still to be developed.

Vanadium

Vanadium is distributed widely in the earth's crust and is no rarer than nickel or zinc. However, there are few deposits which are concentrated enough to justify mining, the largest source at present being the carnotite mines of the Colorado area. Vanadium has been obtained in metallic form by the reduction of the trioxide with calcium under a controlled atmosphere. The principal producer of ductile vanadium, at present, uses a process which has not been disclosed. The product is a mass of crystalline material which is consolidated by sheath rolling or by melting in the argon arc. Sheet or foil are formed by hot rolling to approximately ¼ in., annealing, and cold rolling to the desired thickness. Wire has been drawn to sizes as fine as 0.005 in. Vanadium is available commercially in the form of plate, bars, sheet and wire.

Properties

The physical and mechanical properties of the metal are included in the tables. The density, melting point, and co-efficient of expansion of vanadium approach those of zirconium. The modulus of elasticity of vanadium is twice that of zirconium, and the modulus-density ratios for steel and vanadium are practically identical. The electrical conductivity of the



Vanadium produced by the Electro-Metallurgical Div. is available as ingots, plate, strip and remelting chips.

Cold-rolling of vanadium strip for the production of springs. (Electro-Metallurgical Div.)

metal is less than one-tenth that of copper. Vanadium reacts with oxygen and nitrogen at moderately elevated temperatures and absorbs hydrogen. These gases can cause brittleness. It has been stated that brittleness results if the metal contains more than one-tenth percent of oxygen or more than three hundreths percent of nitrogen.

The corrosion resistance of ductile vanadium has not been thoroughly investigated. The metal is resistant to attack by sea water and salt spray. It is not attacked by moderate concentrations of hydrochloric and sulfuric acid but is dissolved by nitric acid in any concentration. Oxidation begins at 575 F and increases rapidly at temperatures above 750 F. The nitride is formed at temperatures above 1300 F. Both oxide and nitride are soluble in the metal.

Processing

Fabrication—Vanadium has relatively good workability at slightly elevated temperatures and can be formed by bending, stamping and pressing. Moderately deep drawing operations have been performed on it.

Machining—The machinability of vanadium resembles that of cold-rolled steel. Cutting tools with rake angles of 15 deg and clearance angles of 7 to 15 deg have been used successfully in milling. A good surface finish is obtained by employing high cutting speeds, with light cuts. Kerosene is a satisfactory lubricant.

Heat Treatment—Vanadium can be fully annealed by heating to 1650 F for an hour in a vacuum or an inert-gas atmosphere. Stress-relief annealing can be accomplished at 1100 F under an inert atmosphere.

Cleaning and Finishing—Conventional methods of degreasing and cleaning can be used.

Joining—Vanadium can be welded with a Heliarc torch under an argon atmosphere. Special apparatus providing thorough shielding with argon is desirable.

Applications

Ductile vanadium is at present employed by the AEC in classified applications. For the future, the metal will probably be used for service where its high electrical resistance and constant temperature coefficient of resistance are advantageous. Other possible applications include apparatus for handling corrosive solutions and for service in contact with salt water.

Hafnium

Hafnium always occurs associated with zirconium, and the two metals have properties which are somewhat similar. Separation is difficult but is made by chemical means, while metallic hafnium is obtained by either the iodide or Kroll process after such separation. The resulting metal may contain less than 1% zirconium. After melting in an arc furnace under argon, it can be hot rolled (1550 F) in air into desired shapes. Experimentally, hafnium has been cold-swaged and rolled with a reduction of 30% without serious edge-cracking. It has been produced in the form of sheet and rod. The metal is not available commercially in any form at present.

Properties

The density is roughly twice that of zirconium while the melting point is about 500 F higher. The electrical conductivity is only 6% that of copper.

Crystal bar produced by the iodide process has a hardness of Rockwell B 78. Hafnium is gas sensitive like zirconium, and its ductility is affected seriously by absorption of oxygen or nitrogen. No deoxidizers are known.

The corrosion resisting properties of hafnium have not been fully explored. Preliminary data indicate that the metal is resistant to oxidizing acids, including fuming nitric, but is attacked by hydrofluoric. Hafnium oxidizes in air as readily as zirconium, but rate of penetration of oxygen into metal is lower.

Processing

Hafnium can be hot worked in air at 1550 F. Cold working to a maximum reduction of 30% between anneals is possible. The machinability of hafnium resembles that of 18:8 stainless steel.

Cold worked hafnium recrystallizes at about 1380 F, and annealing can be carried out at that temperature in a vacuum or an inert atmosphere. The metal transforms from hexagonal close-packed (the room temperature modification) to body-centered cubic structure at 2400 F. As yet no data are available on cleaning, finishing and joining hafnium. No applications for hafnium have been developed.

Acknowledgment

We wish to acknowledge with sincere appreciation the help we have obtained in the preparation of this manual from the publications and personnel of the following organizations:

The American Welding & Manufacturing Co.
Battelle Memorial Institute
Cleveland Tungsten, Inc.
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E. I. du Pont de Nemours & Co., Inc.
Electro Metallurgical Div., Union Carbide & Carbon Corp.
Fansteel Metallurgical Corp.
Foote Mineral Co.
General Electric Co.
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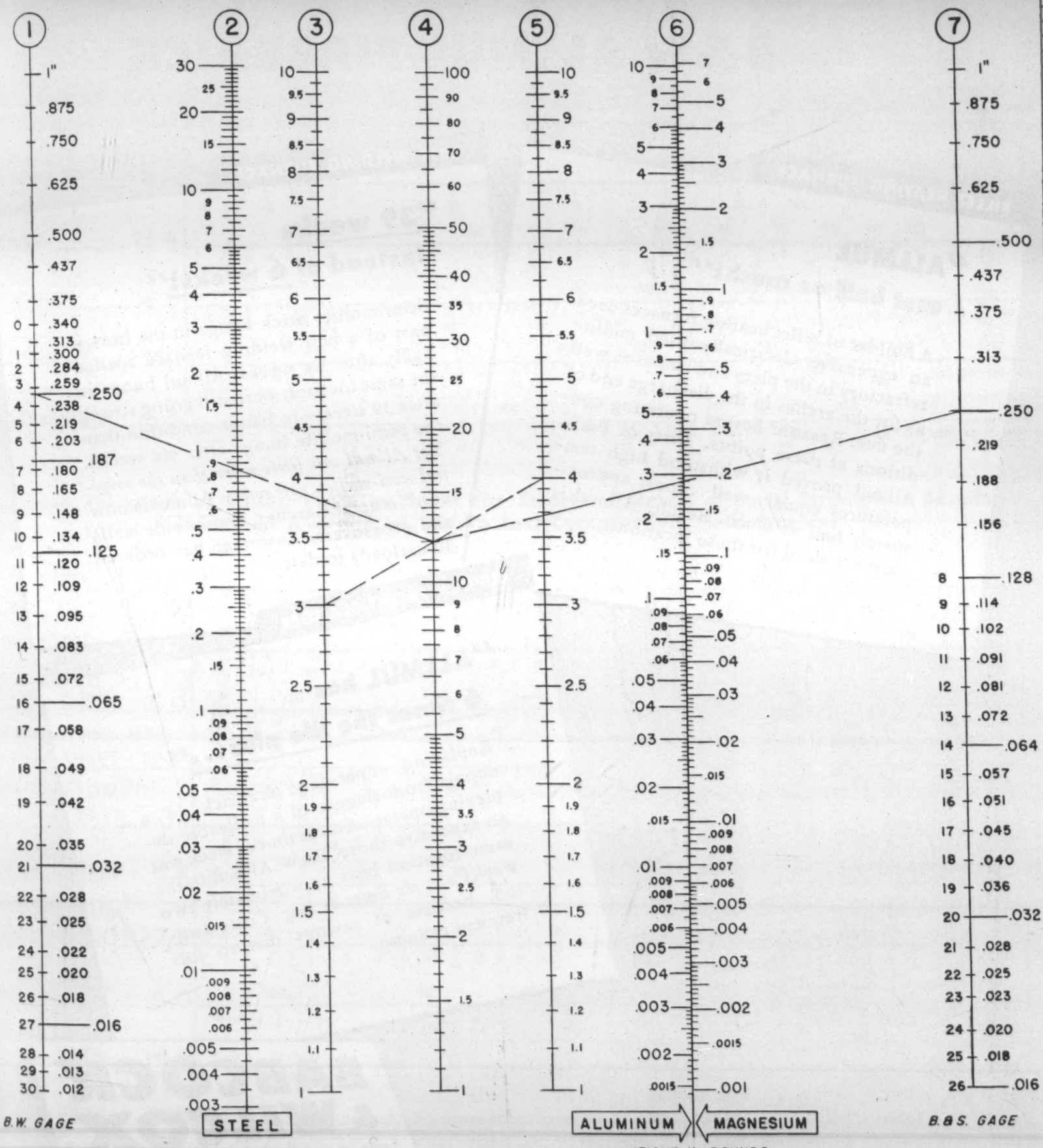
U. S. Bureau of Mines
Research and Development Board, Department of Defense
National Bureau of Standards
Office of Naval Research
Wright-Patterson Air Force Base
Horizons Inc.
Mallory-Sharon Titanium Corp.
P. R. Mallory & Co., Inc.
Metal Hydrides Inc.
Molybdenum Corp. of America
Norton Co.
Rem-Cru Titanium, Inc.
Shenango-Penn Mold Co.
Superior Tube Co.
Sylvania Electric Products, Inc.
Titanium Alloy Manufacturing Div., National Lead Co.
Titanium Metals Corp. of America
Westinghouse Electric Corp.

Materials Engineering File Facts

NUMBER 219
December 1951

MATERIALS:
Magnesium, Aluminum, Steel

Nomogram for Comparing the Weights of Magnesium, Aluminum and Steel



The above nomogram provides a simple means for calculating and comparing weights of magnesium, aluminum and steel parts and, incidentally, for general multiplication and division:

1. Locate length and width of part on lines "3" and "5", respectively. A straight line connecting these points intersects line "4", indicating area of part in sq in.

2. For magnesium and aluminum, locate thickness of part on line "7". Connect this point by straight line with the value found on line "4" and read the weight in pounds on line "6".

For steel, use line "1" for thickness and read the weight value on line "2".

3. For parts whose width or length exceeds 10 in. (or thickness exceeds 1 in.), use the nomogram without regard to decimal point until the weight is obtained. Then move the decimal point of your result as required.

If one, two or all three factors are multiplied by 10, multiply the answer by 10,100, or 1,000, respectively, by moving the decimal point one, two or three places to the right. For example: A magnesium part 3 by 4 by 0.25 in. weighs 0.19 lb; a part 3 by 40 by 0.25 in. weighs 1.9 lb; a part 30 by 40 by 0.25 in. weighs 19 lb; a part 30 by 40 by 2.5 weighs 190 lh.

4. For general multiplication and division, use lines "3", "4" and "5".

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Here's "on the job" proof of furnace savings with

B&W ALLMUL FIREBRICK

BILLET HEATING FURNACE

"ALLMUL cost half as much!"

A builder of billet heating furnaces used an expensive electrically-fused mullite refractory in the piers and baffles as well as for the arches in the discharge end of the flue. Reason? Severe operating conditions at these points. Tests of B&W Allmul proved it withstood high temperatures equally well . . . cost approximately half as much. Result? Allmul is now standard for these locations.

BUTT WELDING FURNACE

"39 weeks instead of 6 weeks!"

Semi-mullite brick bungs in the hottest part of a butt welding furnace spalled badly after six weeks. Allmul bungs in the same location were still going strong after *39 weeks*—in better condition than the semi-mullite bungs after six weeks. *Yet Allmul cost little more than the original semi-mullite refractory.* Allmul is now used in uptake arches, uptake side walls and crossovers. Customer has ordered 30 carloads to date.

CUPOLA FRONT-SLAGGER

"ALLMUL has 6 times the life plus . . ."

Replacing super-duty firebrick in a cupola front-slagger of a malleable duplexing operation three times a week was an expensive chore. B&W Allmul in the same location lasts approximately two weeks . . . *six times as long.* Costs drop, too, because of savings due to less frequent relining.

What's behind the remarkable, money-saving performance of B&W Allmul Firebrick? The answer lies in its low first cost for a fused mullite brick and unique combination of excellent refractory properties: high hot load strength, high resistance to spalling, good volume stability, a high melting point of 3335F. Bulletin R-29 gives all the facts on Allmul. Write for your copy.

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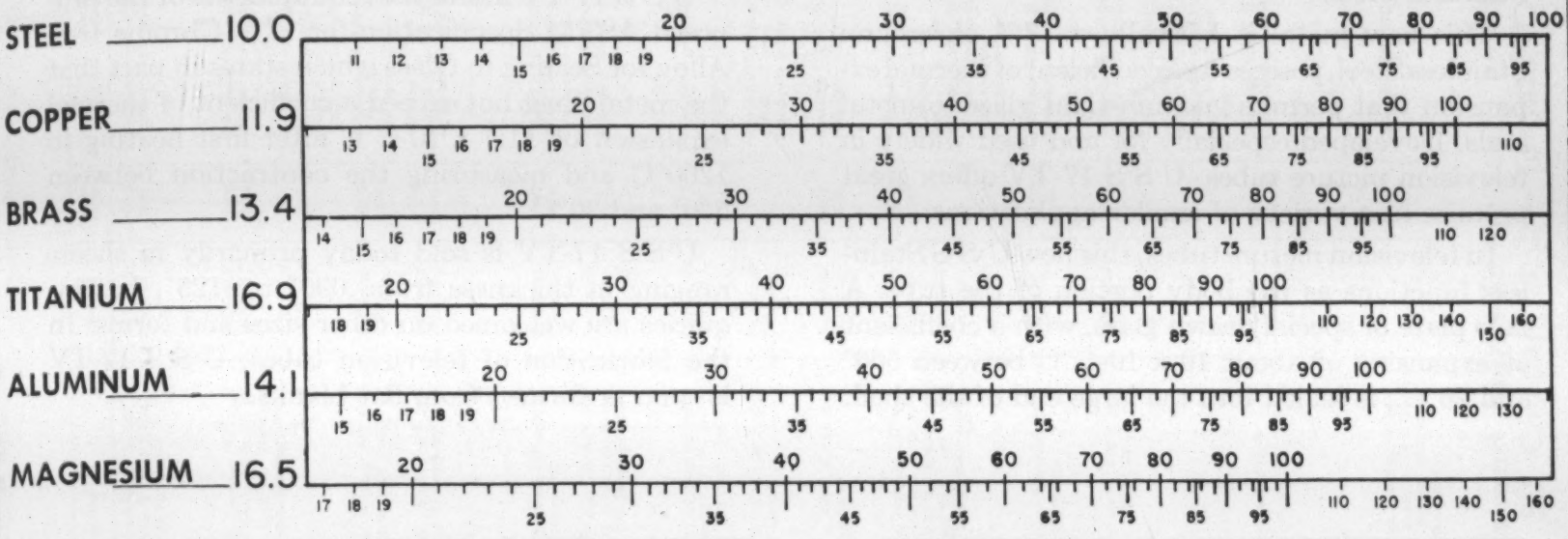
Materials Engineering File Facts

NUMBER 220
December 1951

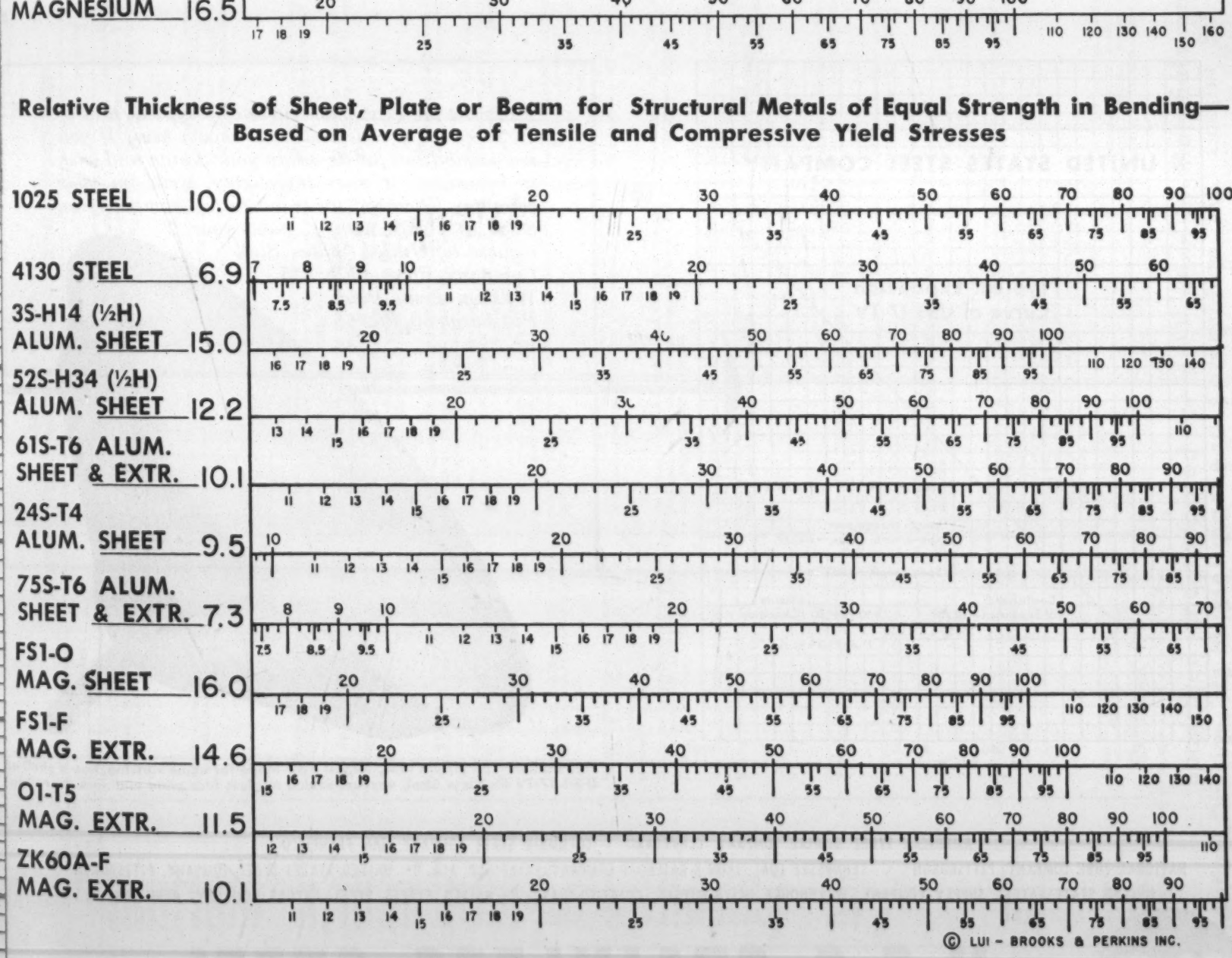
MATERIALS:
General

Scales for Determining Stiffness and Strength of Structural Metals

Relative Thickness of Sheet, Plate or Beam for Structural Metals of Equal Stiffness



Relative Thickness of Sheet, Plate or Beam for Structural Metals of Equal Strength in Bending—Based on Average of Tensile and Compressive Yield Stresses



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This series of logarithmic (slide rule) scales are so arranged as to provide a means for finding the relative sheet, plate or beam thickness required for various metals of equal stiffness or equal strength, respectively.

Corresponding values for different materials may be read vertically in line within each of the two sections.

The theoretical relationships shown have to be interpreted with proper decimal point. For example, 0.049-in. aluminum sheet has the same stiffness as 0.035-in. steel or 0.058-in. magnesium. Similarly, from the same reading an aluminum beam of 4.9-in. depth corresponds in stiffness to 3.5-in. steel and 5.8 magnesium.

Courtesy of "The Magazine of Magnesium"

Designers:

What can you do with this new U·S·S Stainless Steel?

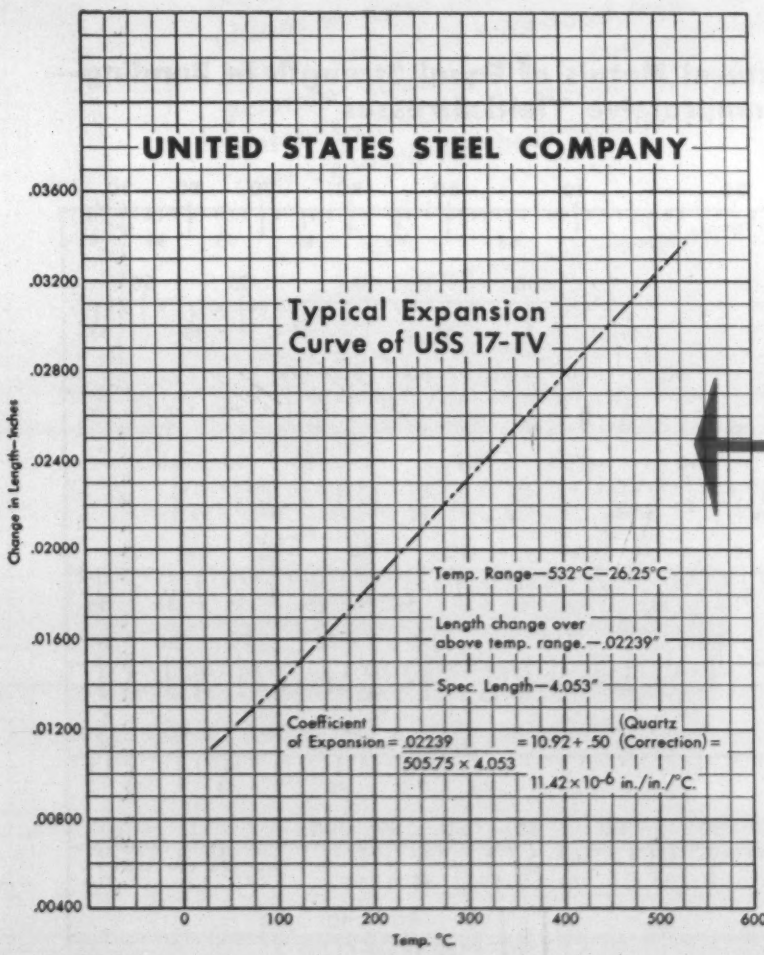
IF you are designing products that require a tight glass-to-metal seal, it will pay you to investigate thoroughly the properties of U·S·S 17-TV Stainless Steel.

This new metal is basically a 17% chromium Stainless Steel, possessing a coefficient of thermal expansion that permits vacuum-tight glass-to-metal seals. Developed especially for and used widely in television picture tubes, U·S·S 17-TV offers great promise in a variety of similar applications.

In television picture tubes, this new U·S·S Stainless functions as the body portion of the tube. A face plate of special drawn glass, with a coefficient of expansion of about 10 x 10^{-6}/°C between 500° and 25°C., is sealed into the large end of the shell. A glass neck funnel of industrial type glass, with a coefficient of expansion of 9.5 x 10^{-6}/°C, is sealed to the small end of the Stainless Shell.

U·S·S 17-TV meets the requirements of the proposed ASTM Specification for 17% Chrome Iron Alloy for Sealing to Glass which states in part that the metal must not exceed a coefficient of thermal expansion of 11.7 x 10^{-6}/°C after first heating to 1200°C and measuring the contraction between 530° and 30°C.

U·S·S 17-TV is sold today primarily in sheets ranging in thickness from .090″ to .125″, but inquiries are welcomed on other sizes and forms. In the fabrication of television tubes, U·S·S 17-TV is spun or formed from flat blanks.



Examine the expansion curve of a typical heat of U·S·S 17-TV Stainless Steel shown here. If you see possibilities for its use in your design and wish to investigate it more thoroughly, write on your company letterhead for a laboratory sample (size, 8″ x 10″; gage, .100″). Send your request to United States Steel Company, Room 4301, 525 William Penn Place, Pittsburgh 30, Pa.

This Dumont 30″ picture tube, largest ever made for home viewing, has a shell of U·S·S 17-TV Stainless Steel, vacuum-sealed to glass face plate and neck assembly.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND · COLUMBIA STEEL COMPANY, SAN FRANCISCO
NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, FAIRFIELD, ALA. · UNITED STATES STEEL COMPANY, PITTSBURGH
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

1-1674

UNITED STATES STEEL

WHIZ KLAD KOTES-CORROSION PREVENTIVES

R. M. Hollingshead Corporation
Materials Engineering File Facts
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REVISED AUGUST 1951

REVISED TO CONFORM WITH LATEST GOVERNMENT SPECIFICATIONS

TYPES	NAME	GOVERNMENT SPECIFICATION	DESCRIPTION	USES	APPLICATION	REMOVAL	FLASH POINT	PROTECTION REQUIREMENTS
SOLVENT TYPES (1) Dry Film	KLAD KOTE 101	**MIL-C-372** (Formerly) 52C18 Grade I Amend. 1 (Polar No. 1)	Cold dip polar type compound providing semi-hard, thin black film at maximum of 0.004 inches thickness.	Intended for use on ferrous and other corrodible metals for long term outdoor storage of such equipment as machine tools, dies, farm machinery, automotive equipment, etc.	Dip, spray or brush between 40° to 120°F. Dries sufficiently within 8 hours for handling. Sets in about 24 hours.	Petroleum Solvents	100°F. min.	**Weatherometer**—50 days **Salt Spray (4% solution)**—28 days
	KLAD KOTE 102	**MIL-C-6706** (Formerly) Army-Navy AN-C-52b Type I Amend. I	**Cold dip liquid providing semi-hard film at maximum thickness of 0.004 inches.**	**All purpose long term preservative for use on all corrodible surfaces exposed to outdoor storage conditions.**	**Dip, spray or brush between 70° and 95°F. Film sets up within 24 hours at room temperature enabling handling with a moderate transfer of compound.**	Petroleum Solvents	**100°F. min.**	**Salt Spray (20% solution)**— Polished Aluminum 4 wks. Polished Steel 3 wks. Sandblasted Steel 1 wk. **Humidity (120°F. @ 95-100% R.H.)**— Polished Aluminum 4 wks. Polished Steel 4 wks. Sandblasted Steel 4 wks.
	KLAD KOTE 103	**Army Ordnance AXS-673 Rev. 2**	Quick-drying cold dip liquid. Provides film 0.008 inches thick.	Long-term preservative for use where surfaces are exposed either to outdoor or indoor conditions. Used particularly where a fast drying compound is desired.	Dip, spray or brush between 60° and 90°F. Dries normally within 4 hours.	Petroleum Solvents	100°F. min.	**Alternate Humidity—Ultra Violet Light Cycle Test**—30 days minimum **Salt Spray (20%)**—10 days
(2) Oily Film	KLAD KOTE 122	**MIL-C-372** (Formerly) Navy Dept. 52C18 Grade II Amend. I (Polar No. 2)	Cold dip, polar, non-drying type compound, providing oily film approximately 0.002 inches thick	Intended for use on ferrous and other corrodible metals where undercover or indoor storage is provided; on interior and on exterior surfaces of all machinery and instruments, and on all interiors of gasoline and Diesel engines (will neutralize acidic residues of internal combustion engines). Material is soluble in fuel, Diesel and lubricating oil.	Dip, spray or brush between 40° and 120°F. Sets up within 24 hours for handling.	Petroleum Solvents	100°F. min.	**Salt Spray (4%)**—14 days **Humidity (100°F. @ 95-100% R.H.)**—40 days **Hydrobromic Acid Test**—No corrosion
	KLAD KOTE 172	**Army Ordnance AXS-1759 Grade II**	Cold dip providing an oily film at thickness of 0.0008 inches, with water displacing properties.	Intended primarily in conjunction with some type of barrier material for use on critical phosphated and parkerized surfaces in long term storage.	Dip, spray or brush between 50° to 90°F. Remains as a soft grease film.	Petroleum Solvents	100°F. min.	**Humidity (100°F. @ 95-100% R.H.)**—30 days **Water Displacement Test**—Passes **Performance in Rifle, M1**—Passes
(3) Soft Film	KLAD KOTE 124	**Army-Navy AN-C-124a Type I Amend. III**	Cold dip liquid compound, providing easily removable soft grease film approximately 0.002 inches thick.	Generally recommended for protection of critical surfaces where indoor storage is provided and where a soft non-hardening easily removable film is desired. Will not afford adequate protection for direct outdoor exposure but will protect parts for a minimum of one year under normal indoor storage conditions.	Dip, spray or brush between 70° and 90°F. Material sets to a soft greasy film upon evaporation of solvent. (Approximately 24 hours.)	Petroleum Solvents	100°F. min.	**Humidity (100°F. @ 95-100% R.H.)**—30 days **Salt Spray (20%)**—14 days
	KLAD KOTE 171	**AXS-1759** Grade I	Cold dip, soft thin film. Easily removable. The film thickness is 0.002 inches.	Intended for the preservation of critical surfaces for long term indoor storage.	It may be applied by dipping, spraying or brushing, between 50°F to 110°F. Film sets up within one hour. Remains soft and greaselike.	Petroleum Solvents	100°F. min.	**Ultra Violet—Humidity 20 Cycles** (days) **Salt Spray (20%)**—4 days Film will not flow below 140°F.
PETROLATUM GREASE TYPES	KLAD KOTE 221	**U. S. Army 2-121** (Formerly) Ord. Dept. AXS-1001	Hot dip solid grease providing non-hardening film at thicknesses of 0.003 to 0.0045 inches. Melting Point 140°F. min.	Recommended for use on critical surfaces during long term indoor or temporary outdoor storage conditions.	Dip, spray, or swab 175° to 200°F. Sets on cooling to a firm grease.	Petroleum Solvents		**Alternate Humidity—Ultra Violet Light Cycle Test**—14 days **Salt Spray (20%)**—10 days
	KLAD KOTE 224	**Army-Navy AN-C-124a Type II Amend. III**	Hot dip soft grease compound providing a soft greasy film 0.002 inches thick. Melting Point Range — 125° to 150°F.	For indoor protection of highly machined precision equipment such as ball and roller bearings, etc., where a soft easily removable film is desired.	Dip between 138° to 180°F. Forms firm grease film upon cooling.	Petroleum Solvents	350°F. min.	**Humidity (100°F. @ 95-100% R.H.)**—30 days **Salt Spray (20%)**—14 days
	KLAD KOTE 252	**MIL-C-6708** (Formerly) Army-Navy AN-C-52b Type II Amend. I	Hot dip firm grease providing film at 0.004 inches thickness. Melting Point 150°F. min.	Compound provides same type of film and protection as Type I (Klad Kote 101) but has added advantages of setting immediately upon cooling and of more uniform film obtainable through hot dipping.	Hot dip or swabbing between 170° and 210°F. Compound sets firm upon cooling. Heating part prior to dipping will eliminate any flaking tendencies of the compound and will also provide a thinner film.	Petroleum Solvents	350°F. min.	**Salt Spray (20%)**— Polished Aluminum 4 wks. Polished Steel 1 wk. Sandblasted Steel 1 wk. **Humidity (120°F. @ 95-100% R.H.)**— Polished Aluminum 4 wks. Polished Steel 4 wks. Sandblasted Steel 4 wks.
OILS	KLAD KOTE 356	**Army Air Force AAF 14156 Amend. I**	Cold dip fingerprint neutralizer. Viscosity 50 Saybolt secs. at 100°F.	Intended for use as a fingerprint neutralizer for removing fingerprint stains from highly polished surfaces. When used as a short term slush no further protection is generally required.	Dip where practicable, otherwise spray or brush at room temperature.		100°F. min.	**Humidity (120°F. @ 95-100% R.H.)**—100 hrs. **Fingerprint Removal Test**—Passes
	KLAD KOTE 365	**NONE**	A light bodied slushing compound with water displacing properties.	Used where a light oil coating completely miscible and compatible with light aliphatic petroleum solvents is desired. Excellent as a "between operation" slush for machined parts or where short term indoor storage up to 6 months is contemplated. Has excellent water displacing properties.	Applicable by dip or spray at room temperature. Soluble in lubricating oil.	Petroleum Solvents	100°F. min.	**Corrosion Test (96 hrs. @ 100°F.)** — Passes. **Humidity (120°F. @ 95-100% R.H.)**—4 wks. Polished Steel Sandblasted Steel Lead Plated Steel Lead and Indium Plated Steel Cadmium Plated Steel Silver Plated Steel Copper
	KLAD KOTE 376	**Army-Navy AN-VV-C-576b Type I Amend. II**	A medium oil preservative used either in concentrate or blended with lubricating oil.	Used in concentrate as a general purpose coating for precision parts under normal indoor storage conditions. When blended 1 to 3 with engine oil, it is used as an internal engine preservative for all reciprocating type combustion engines, particularly aircraft engines. Compound tends to neutralize acidic residues resulting from combustion. Engine may be operated up to 50% rated power when used.	Dip or spray at room temperature.	Petroleum Solvents		**Humidity (120°F. @ 50% R.H.)**—150 hrs. **Hydrobromic Acid Neutralization Test**—Passes
	KLAD KOTE 378	**Army-Navy AN-VV-C-576b Type II Amend. II**	Mixture of 75% oil conforming to Specification MIL-O-6082 Grade 1100 or 1120 and 25% concentrate AN-VV-C-576b, Type I, Amend. II.	(See Klad Kote 376)	After filling crankcase, operate engine at reduced speed (not to exceed 50% rated power) to circulate through engine. Remove by draining crankcase.		350°F. min.	(See Klad Kote 376)

Most KLAD KOTES are stocked for prompt delivery and are obtainable in 5 and 55 gallon containers.

Sponsored and prepared for publication in **Materials and Methods** by
Industrial — Aviation Division, **R. M. Hollingshead Corporation**, 900 Cooper St., Camden, N. J. — Toronto, Ont., Canada

THERMALLOY "30"

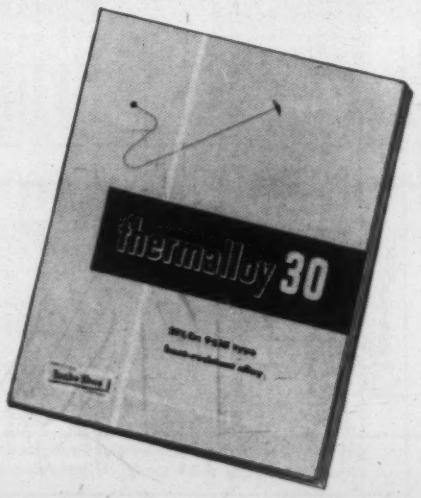
A cast heat-resistant alloy with high aged ductility

For service in the 1200°-1600° F. range

WRITE FOR NEW FREE FOLDER

Thermalloy* "30"—a 21% Cr 9% Ni alloy—has outstanding aged ductility characteristics and hot strength equal to that of 25% Cr 12% Ni type alloys. Since its alloy content is lower, Thermalloy "30" is also somewhat more economical.

In tests involving over 100 heats, excellent data has been obtained on stress rupture properties, aged ductility, oxidation resistance and mechanical properties. For additional information write for Bulletin T-211. Electro-Alloys Division, 2084 Taylor St., Elyria, Ohio.



THERMALLOY "30" OFFERS:

- ***Improved Ductility***— 18% minimum after aging for 24 hours at 1400° F.
- ***Uniform Strength Levels***— equivalent to and more uniform than 25% Cr 12% Ni types.
- ***Greater Economy***— since quantity of alloying elements is less than in similar types.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION

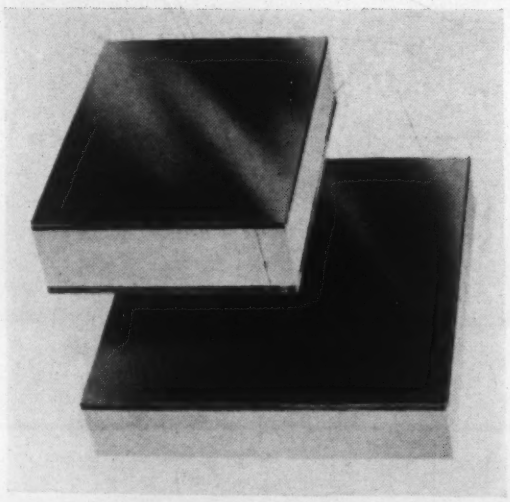
ELYRIA, OHIO

New Materials and Equipment

Metal Surfaced Dielectric Sheets

A new series of metal surfaced dielectric materials, offered under the trade name Chemelec Multi-Bond, is currently being offered by the *Fluorocarbon Products Div., U. S. Gasket Co.,* Camden 1, N. J.

Dielectric materials include pure fluorocarbon resins and mixtures of fluorocarbon resins with various other materials, such as asbestos, mica, fiberglass, glass, ceramics, quartz, zero-plast, calcium fluoride or calcium silicate, depending upon the characteristics desired in the product. The metal surfaces available on any of these materials include aluminum boron carbide, copper, Alnico, monel, lead, mu metal, solder, tin, magnesium, iron, steel, molybdenum, nickel, Nichrome, zinc, bronze, brass and the precious metals.



These metal surfaced dielectric sheets are adaptable to a wide variety of uses requiring the bonding of a dielectric material to metal components.

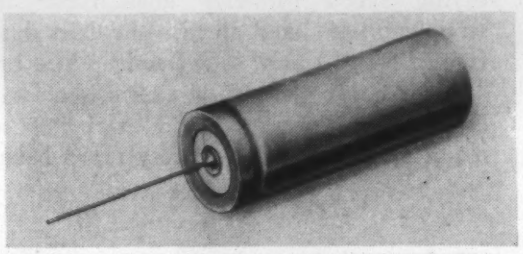
Sheets can be metallized on one or both surfaces, and standard thicknesses of dielectric material range from 0.030 to 1.50 in., and of the conducting metal surface from 0.004 to 0.25 in. The thickness of the Multi-Bond area ranges from 0.008 in. to a homogeneous mass.

Due to the elastic properties of the fluorocarbon plastic and the interlocking nature of the bond, Chemelec Multi-Bond has no acute strain point due to unequal rates of thermal expansion as with glass-to-metal or ceramics-to-metal seals. Also, the resiliency of the plastic permits the sheets to withstand severe mechanical shock and vibration.

Chemelec Multi-Bond is said to be ideal for fabricating moisture proof printed circuits for electronics requirements and is adaptable to a wide variety of purposes requiring the bonding of a dielectric material to metal components.

A new line of Chemelec hermetic seals, which are recommended for use where severe service conditions are encountered, are also being offered by the company.

Utilizing an exclusive method of producing a fused hermetic seal between Teflon and metal, a metal surface is applied to the outer edge and center of the seal. The design is said to simplify assembly as it eliminates exhaust vents. The center eyelet accommodates the condenser wire with a loose fit to allow exhausting prior to sealing.



This vacuum tight seal is recommended where severe service conditions are encountered—vibration, shock, high and low ambient temperature and thermal shock.

Because of the elasticity of the plastic and the nature of the fused seal, the new seals have no acute strain point due to unequal rates of thermal expansion, as with glass-to-metal and ceramics-to-metal seals. Also, resiliency of the plastic permits them to withstand severe mechanical shock and vibration in service, and there is no danger of breakage in assembly.

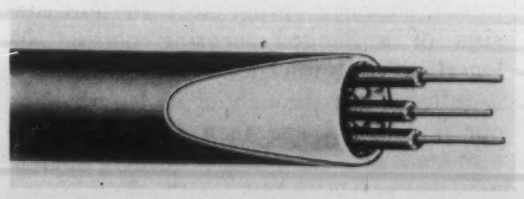
These seals are especially applicable for capacitator can sizes from 0.377 to 0.962 in. They will not d.c. plate, and are serviceable at temperatures from—110 to 500 F without appreciable change in electrical characteristics. Because of zero water absorption, they are said to be unaffected by extreme humidity. They are nonflammable and impervious to corrosive atmospheres and fungus.

Plastic-Coated Metallic Tubing Offers Greater Corrosion Resistance

Samuel Moore & Co., Mantua, Ohio, has announced a new plastic armored electrical metallic tubing for use where corrosive atmospheres necessitate frequent replacement of electrical conduit.

Dekoron conduit is made by the company's patented extrusion process: a 0.020-in. coating of tough, corrosion resistant vinyl or polyethylene plastic is extruded over standard galvanized electrical metallic tubing. By varying the thickness and composition of the plastic armor, the conduit can be given any desired dielectric properties. According to the manufacturer, the tubing is impervious to corrosive effects of moisture, salt air, acids, alkalies, oils and grease, and is immune to normal temperature changes.

Fabrication and installation of the tubing is said to be easy and can be accomplished without the use of special tools. Standard compression type couplings and connectors wrapped with electrical insulating tape are used at joints.



This plastic coated electrical metallic tubing is said to be impervious to corrosive effects of moisture, salt air, acids and alkalies.

New Materials and Equipment continued

Paint Resin for Fast Air-Dry or Rapid Bake Finishes

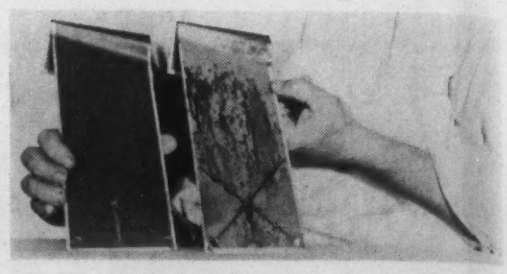
Painting and priming of industrial and consumer goods will be speeded by a versatile new Glyptal alkyd resin manufactured by the Chemical Division, *General Electric Co.*, Pittsfield, Mass.

Designated as G-E Glyptal 7422, the new paint resin is a short, pure, oil-modified alkyd, free of rosin, phenolic, styrene or other modifiers. It is said to possess drying speed formerly unattainable in straight oil-modified alkyds—air dries dust free in 5 to 10 min; tack free in 3 to 4 hr.

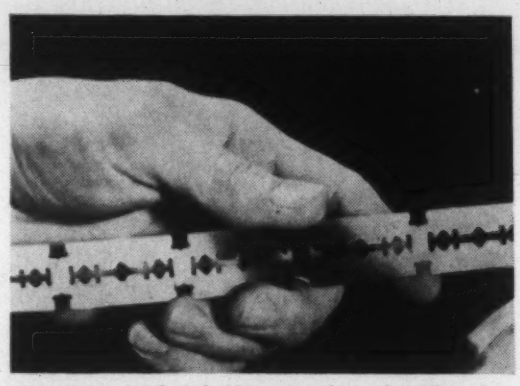
Exceedingly versatile, the resin is recommended for a variety of industrial finishes requiring fast air-dry or very rapid bake. It is claimed to have excellent color retention, adhesion, toughness, mar resistance and salt spray resistance.

The new vehicle also produces high-quality primers for metals. It dries quickly to an insoluble film that is not lifted by succeeding coats, and can be used to meet the very rapid dry and rigorous performance requirements of aircraft primer specifications MIL-6889-A without the use of phenolic dispersion resins.

Recommended applications include appliance and furniture finishes, primers, automotive and metal cabinet finishes, and venetian blind enamels.



Demonstrated here is the new resin's resistance to salt water: the panel at right has been coated with a popular alkyd primer while the new has been used at left.



Here is a finished strip for double-edge blades: brushing removes heat-treat scale and prepares the strip for etching.

Power Brushes Combine Two Operations

By combining two individual production processes into one automatic brushing operation, the new power brushes offered by *Osborn Manufacturing Co.*, Cleveland, are said to be effecting considerable savings, in addition to providing higher quality finishes.

The two jobs done by the brushes are: removing heat treat scale and preparing the strip surface for name etching. These operations were formerly done by machines having six brushing heads. Now, however, this use of the new brushes and improvements in hardening techniques have enabled the manufacturer to reduce to a two-station automatic machine that does both operations simultaneously.

The cutting tool strip is pulled through the power brushes at 50 ft per min. The brushes, rotating at 3450 rpm, reverse as they become grooved from wear. Bevel gears move the brushes up or down as required. These two stations do the work of six stations of the former method. The strip comes out uniformly clean and micro-smooth ready for name etching.

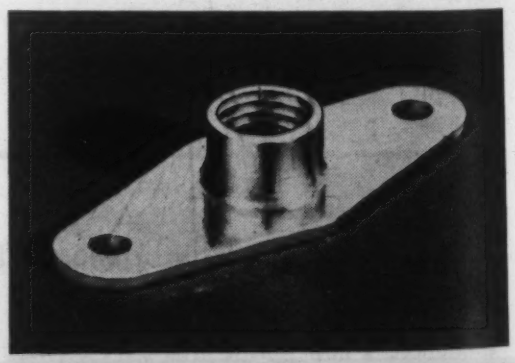
Self-Locking Anchor Nuts Offer Many Unusual Features

A complete innovation in self-locking anchor nuts has been announced by *Kaynar Manufacturing Co., Inc.*, Los Angeles. Incorporating many new features, the new product is of all spring-steel and is made to Army, Navy and Air Corps specifications.

According to the company, the nut is simple in design and is made on high production stamping equipment which places it in a low cost bracket. Made of high carbon annealed spring steel, the nut consists of a flanged ancoring portion integral with a thin-walled drawn shell which is fully tapped throughout its length. The nut is crimped and then heat treated to provide an extremely strong flexible threaded portion which resiliently grips the bolt within the span of the normally required number of threads without necessitating an auxiliary locking device. For this reason, it is lower in height than any existing comparable lock nut and, in addition, because of its high strength, is lighter than any comparable anchor nut.

Extreme elasticity is said to provide exceptional locking torque uniformity, even with large variations in bolt diameter. As the threads are quite hard and therefore wear-proof, and the steel does not lose its resilience readily, an almost unlimited number of insertions and removals can be made without appreciably altering its locking torque.

Advantages of the new anchor nut are many, according to the manufacturer. Because of its all steel construction, it can be used in high temperature applications up to 700 F, and is not adversely affected by lubricants or solvents; being harder than most bolts, it is practically impossible to cross-thread; as there are no locking wings or lugs, it is extremely rugged and difficult to damage; and static load tests



This new ancor nut is made in the solid anchor, floating anchor, and gang channel type of the 1/4-in. size and will be available in sizes ranging from 8 to 3/8 in.

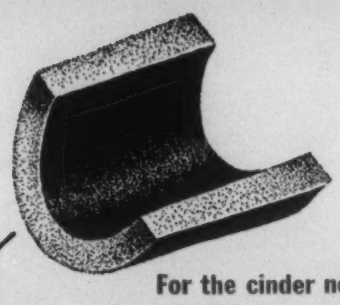
reveal a high axial strength far above that of conventional nuts and well above the most stringent Army and Navy requirements.

(More News on page 114)

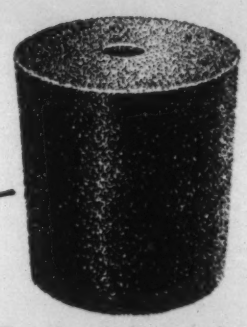
WHEREVER THE HOT STUFF HITS

USE NATIONAL CARBON

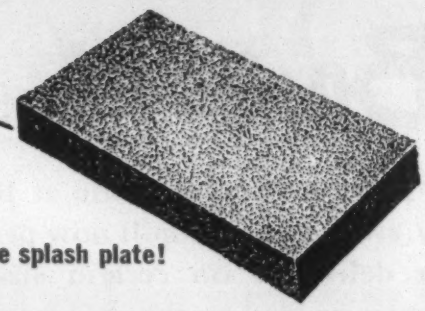
TRADE-MARK



For the cinder notch liner!

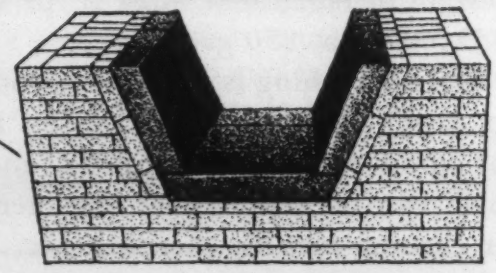


For the cinder notch plug!

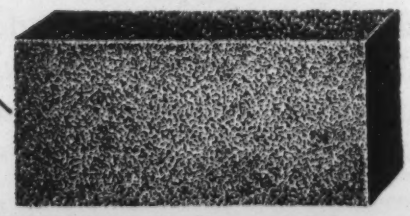


For the splash plate!

For the runout troughs!



For the skimmer plate!



● "National" carbon is now firmly established for blast furnace linings. It is being used outside the furnace as well—wherever there is contact with molten material—for the splash plate, runout troughs —clear down to the ladle—skimmer plate, cinder notch liner and cinder notch plug.

The reasons?

"National" carbon has no melting point. It is highly resistant to slag attack and thermal shock . . . not wet by molten metal . . . has a low thermal expansion . . . and maintains its mechanical strength at elevated temperatures.

Use "National" carbon inside and outside your blast furnaces and you cut down maintenance, speed up production and save money. For more information, write to National Carbon Company, Dept. C.

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY

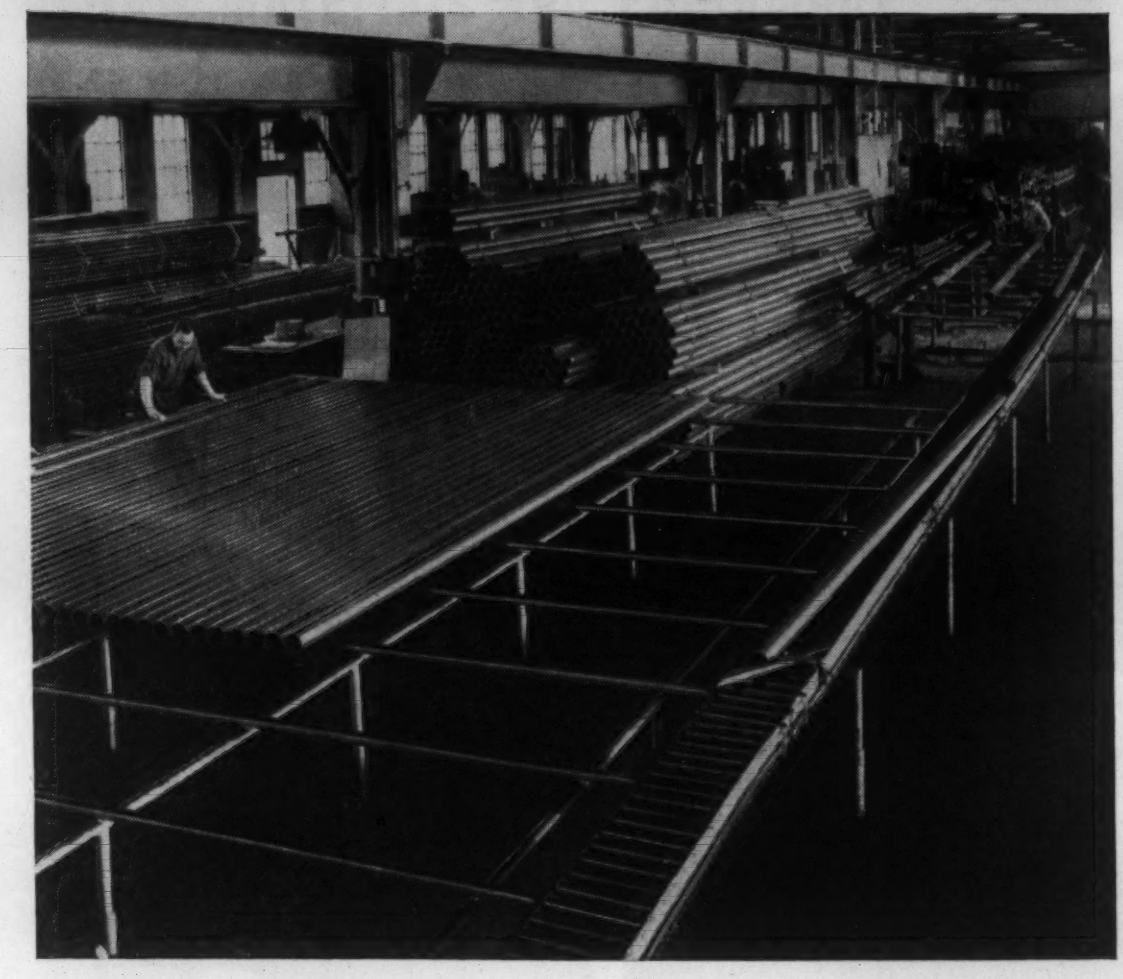
A Division of Union Carbide and Carbon Corporation

30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IN CANADA: National Carbon Limited
Montreal, Toronto, Winnipeg

AVAILABLE FOR FAST DELIVERY

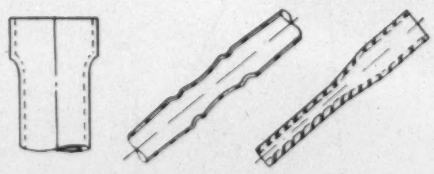


Brainard ELECTRIC WELDED TUBING

EXPANDED production at Brainard's new tube mill now permits fast deliveries on certain sizes of electric welded mechanical steel tubing. Brainard tubing is supplied straight or fabricated, sizes ½" to 4" O.D.; .025 to .180 gage.

Brainard tubing is a uniform product produced to close tolerances. It has good machining qualities, and finish can be supplied as specified: for chrome plating, painting, etc.

Integrated production facilities permit quality control throughout the manufacturing process—from ore to finished tubing. You can depend on Brainard service for *your* needs. District offices in principal cities throughout the U. S.



EASY TO FABRICATE

Brainard electric-welded tubing can be beaded, expanded, swaged, spun, flanged, upset, grooved, fluted, flattened, tapered, and otherwise formed to meet a wide variety of design requirements.

Brainard also pre-fabricates to your requirements; bending, end expansion or taper, internal or external beading, slotting, fastening, etc. Call on Brainard's tubing specialists to save yourself fabrication time and costs.

WRITE FOR FULL INFORMATION

Brainard
SHARONSTEEL
STEEL COMPANY
WARREN, OHIO

Brainard Steel Company
Griswold Street, Warren, Ohio

☐ Send catalog listing complete specifications of Brainard Tubing.

☐ Advise availability of following sizes:_____

Your Name_____

Company_____

Address_____

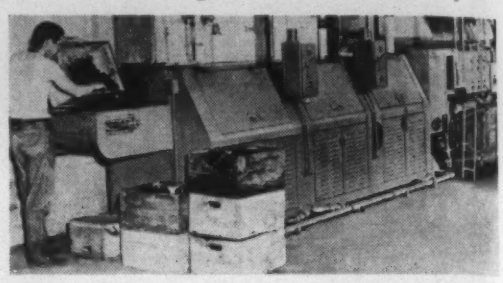
City_____ State_____

New Materials and Equipment

Industrial Washer Washes, Rinses, Dries Small Phenolic Parts

Currently offered by *Industrial Washing Machine Corp.*, New Brunswick, N. J., a new machine, Model SK 12X6, is said to wash, rinse and dry Bakelite parts in volume.

The machine, which can be heated by either steam or gas, solves what was previously a serious problem by efficiently removing Bakelite dust, chips and traces of oil from parts. Featuring a high capacity rate of 5,000 small parts per hr, and proportionately high capacity rates for larger parts, the unit performs a four-cycle cleaning operation—it washes, rinses twice, rinses again with fresh water, and then dries the work.



This machine effectively performs a four-cycle cleaning operation—washes, rinses three times and dries.

All Bakelite chips (some of which are as fine as powder) are said to be completely and thoroughly removed.

Fluorochemicals Perform Previously Impossible Industrial Applications

A new series of fluorochemicals, capable of performing many previously impossible industrial assignments and of making other hard jobs relatively easy, is now being manufactured by *Minnesota Mining & Manufacturing Co.*, St. Paul, Minn.

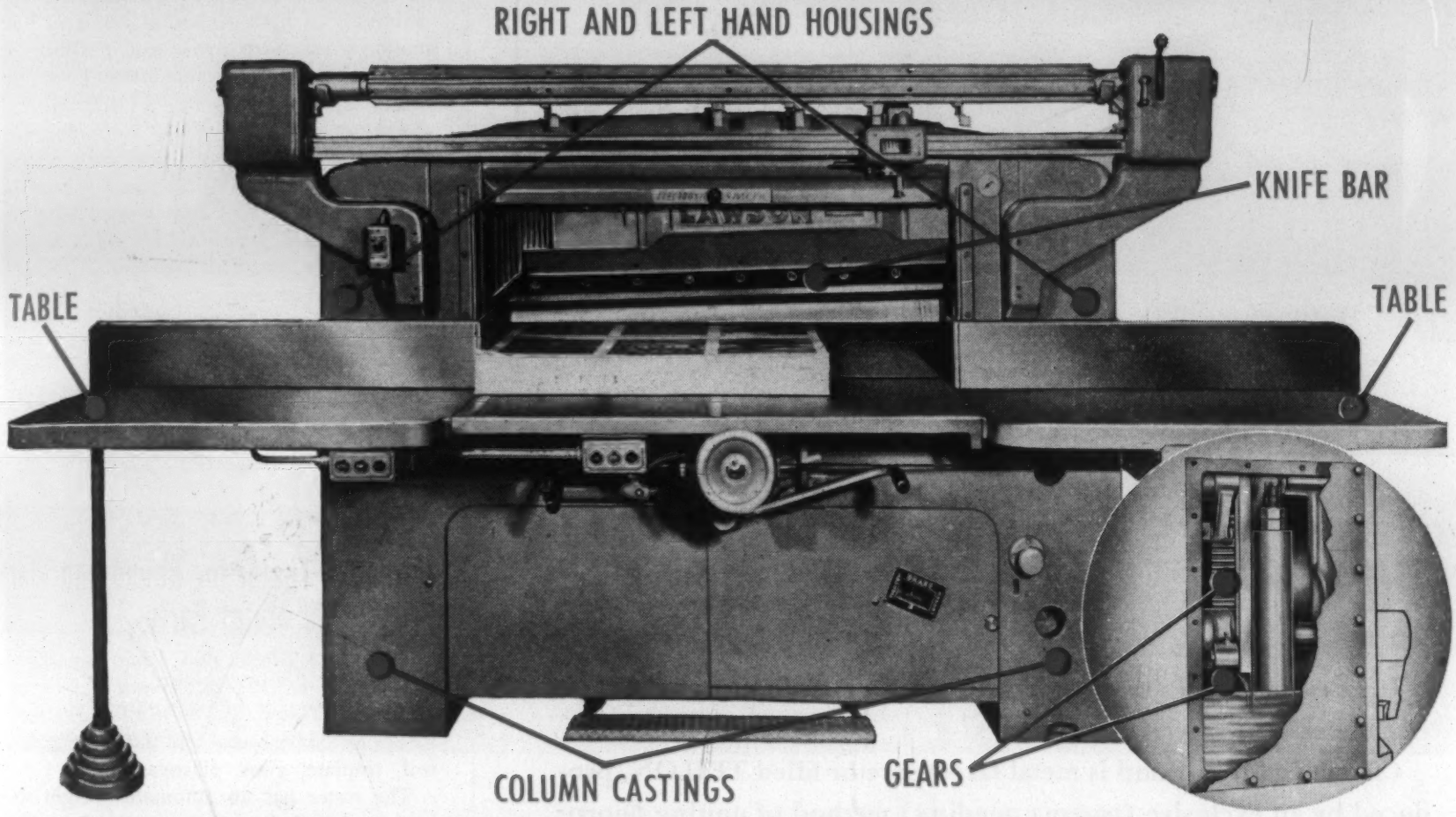
These products are all carbon compounds and each of them contains a high percentage of fluorine. Many of them are said to be new and unique, and it is believed this is the first time they have been produced in quantity.

According to the company, the fluorochemicals will serve as a new group of chemical intermediates for use in the manufacture of other products, giving greater weather resistance, greater heat, greater chemical stability, unusual optical properties, increased surface activity, increased fire resistance, and greater fungus resistance. Among products that may eventually be affected are resins and coatings, pharma-

For the Dependability that only Quality can give

MEEHANITE CASTINGS

are used in all important parts of LAWSON CUTTERS



For more than fifty years E. P. Lawson Co., Inc., New York, has pioneered in the development of precision cutting machinery for the graphic arts industry. The revolutionary hydraulically operated, electronically controlled paper cutter shown is built with the various Meehanite castings indicated. Note that these components are the major parts whose properties and engineering characteristics must provide the dependability of Meehanite quality.

Machinery and equipment manufacturers everywhere are turning more and more to Meehanite castings as the means of meeting rigid material specifications. All production equipment today in all industries must produce more, must last longer, must provide accuracy, dependability and quality. Meehanite components are basic contributors to this end.

Write for our 25th Anniversary booklet "25 Years of Proof in Service."

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Canton, O.
Builders Iron Foundry	Providence, Rhode Island
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
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Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
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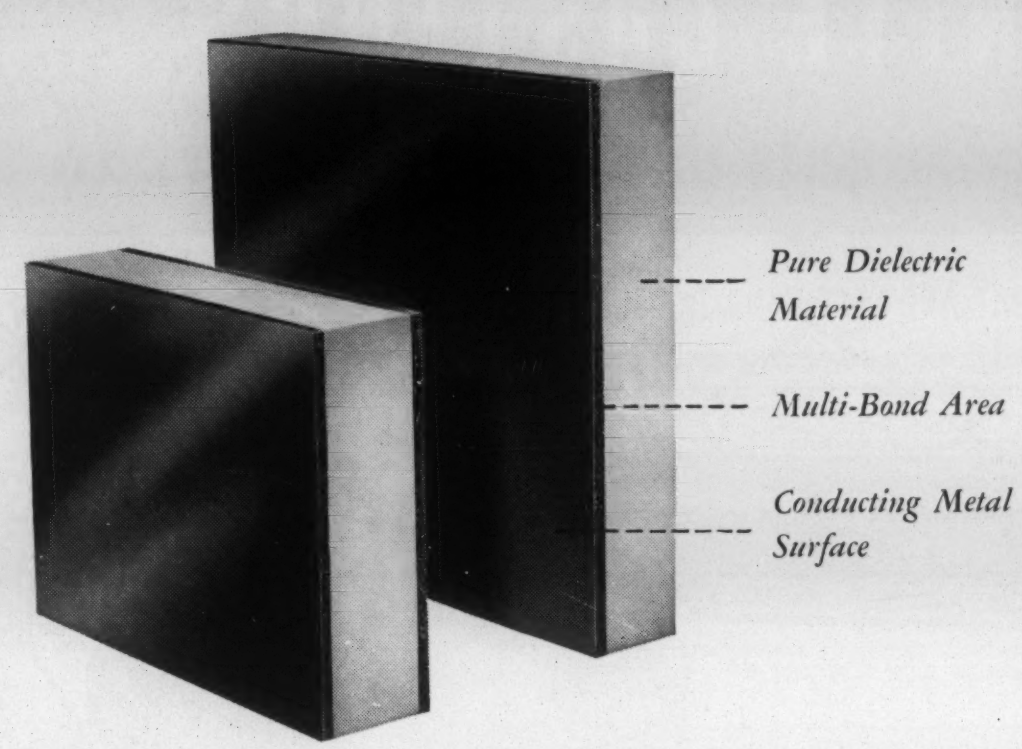
"This advertisement sponsored by foundries listed above."

MEEHANITE® NEW ROCHELLE, N. Y.

CHEMELEC MULTI-BOND



Metal Faced TEFLON*

● Here is the answer to the bonding and hermetic sealing of dielectric materials to metal components.

Chemelec Multi-Bond is metal faced pure or filled TEFLON, produced by an exclusive (patents pending) method of uniting fluorocarbon resins and metals with an interlocking bond unaffected by severe mechanical shock, vibration and unequal rates of thermal expansion.

The bond is micro-crystalline in structure and gradually changes from dielectric to metal, the conducting metal surface being applied by electro-deposition or other conventional means.

Facing metals include practically all the ferrous and non-ferrous metals, the ferro magnetic group and the precious metals.

Sheets are available, metal faced on one or both sides, in thick ness from .034 to 1.75 in. and in sizes up to 36 in. square.

Write for Bulletin MI-424.

**du Pont's trademark for its tetrafluoroethylene resin.*

UNITED STATES GASKET COMPANY

FLUOROCARBON PRODUCTS DIVISION

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FOREMOST FABRICATORS OF "TEFLON" AND OTHER FLUOROCARBON PLASTICS

New Materials and Equipment

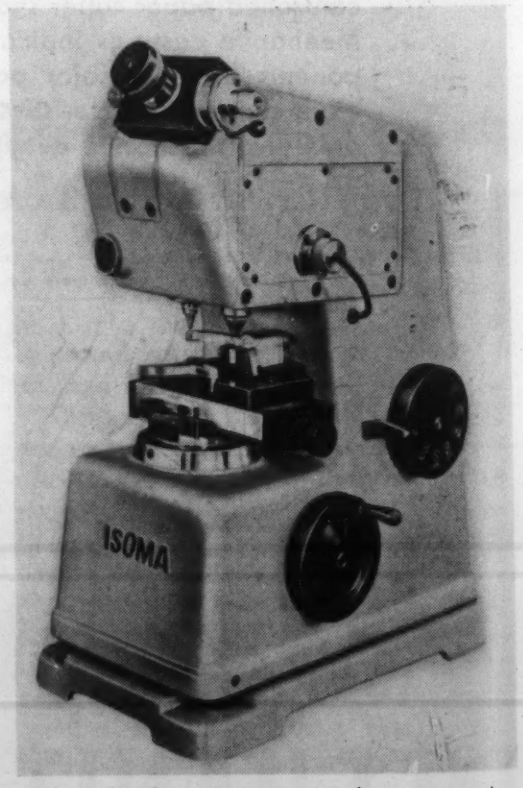
ceuticals, dyes, polymers, solvents, refrigerants, fire-extinguishing compounds, surface-treating agents, dielectrics, hydraulic fluids, and coolants and lubricants. Their resistance to heat, corrosion and acid formation gives them interesting possibilities as permanent lubricants and hydraulic fluids replacing oil.

Certain fluorochemicals, even in small amounts, will produce "wetter" water. Their ability to reduce surface tension is greater than that of any known soap or detergent. The chemicals are a big family and can be tailor-made to meet a diversity of industrial needs.

Hardness Tester for Round and Flat Metal Parts

The Cosa Corp., 405 Lexington Ave., New York 17, has introduced the Isoma Hardness Tester for measuring Vickers values on small, round and flat metal parts, foil, tinplate, glass, plastics, etc.

The tester has an automatic weight selecting device for applying dead weight loads from 50 to 1000 gm. The minimum thickness of flat pieces to be tested is 0.0005 in. Minimum diameter for rounds is from 0.003 in. to 0.005 in. A built-in optical measuring system permits measur-



This hardness tester is for measuring Vickers values on small, round and flat metal parts, foil, tinplate, glass and plastics.

How to get tough with a delicate problem

If you're on the lookout for new basic materials, look at what Naugatuck's new Kralastic resin did for American Optical. Then send the coupon and see what these unusual styrene copolymers can do for you.

As the world's largest suppliers to the ophthalmic professions, American Optical prescription laboratories transfer thousands of lenses a day from one process to another. Finding the right tote boxes was a delicate problem.

For one thing, the surface of the boxes had to be satin-smooth. Even the tiniest dust particles could scratch lenses. And ordinary materials caught dust, made trouble.

So American Optical tried Naugatuck Kralastic.

They found that dust does not become imbedded in Kralastic trays. And these trays are so dimensionally stable that they do not warp! Their perfect fit stays perfect for stacking.

What's more, they are lighter and much tougher than any material used before . . . long wearing, scuff-resistant, not brittle. And their one-piece, crevice-free construction makes cleaning an easy, instant task. And they come in any color.

As with tote boxes, Kralastic has made scores of products from bathroom fixtures to rod handles finer and stronger. Get your Kralastic facts today!

Naugatuck Chemical

Division of UNITED STATES RUBBER COMPANY
NAUGATUCK, CONNECTICUT

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • New York
Philadelphia • In Canada: Naugatuck Chemicals, Elmira, Ontario

Naugatuck Chemical Plastics Division, Elm St., 112
Naugatuck, Conn.

Without charge, send technical data on properties, uses, handling methods (specify desired end products).

I understand that, from this data, I can order suitable, free experimental samples.

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and
GRAPHITE SPECIALTIES

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Carbon ground rods
Electrical contacts
Carbon piles
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Bearings
Brazing furnace boats
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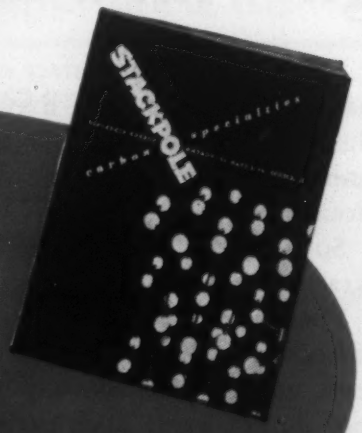
Welding plates and paste
Resistance welding and brazing tips
Molds and dies
Rail bonding molds
Glass molds
Continuous casting dies
Spectrographite



Write for your copy of this 44-page book. Besides describing Stackpole products, it contains data on the amazing versatility of carbon and graphite in modern equipment.

STACKPOLE
"EVERYTHING IN CARBON BUT DIAMONDS"
STACKPOLE CARBON COMPANY
St. Marys, Pa.

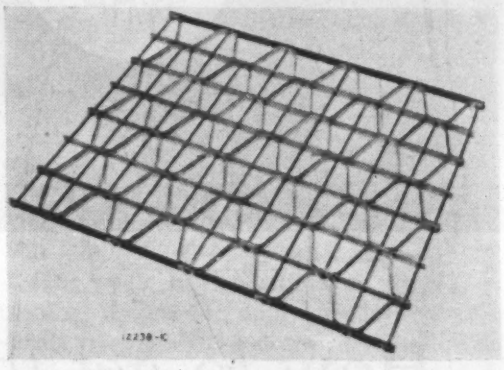
New Materials and Equipment

ing impressions accurately to within 0.000004 in.

Standard equipment includes optical measuring system, transformer for 110 or 220 v, base plate, test block, spare bulbs and table of equivalent values. Special supports and clamps are available for holding thin material and extremely small parts.

Alloy Grid Meets Rigid Requirements of Heat Treating

An alloy grid that successfully meets the rigid requirements of the heat treating field has been designed by *Rolock Inc.*, Fairfield, Conn. The Serpentine grid is very light in weight, yet capable of performing



This alloy grid offers extremely long service life.

with a minimum of distortion for an extremely long service life previously considered impossible.

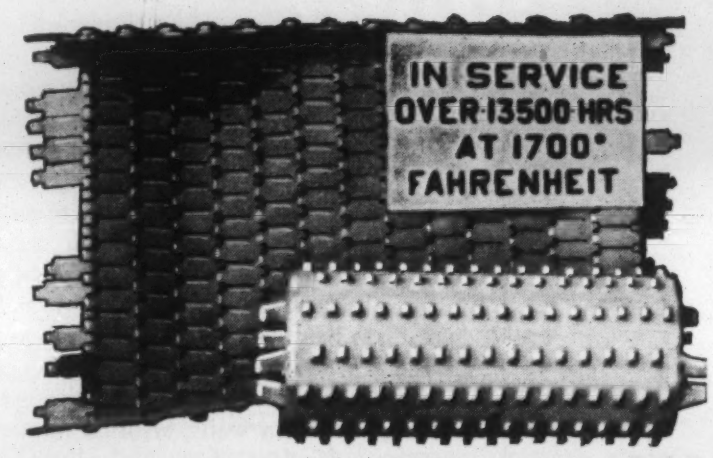
Simple in design and fully articulated with loose tie rods, the grid is constructed with longitudinal bars as the principal load carrying members, spaced with serpentine-like intermediate bars which also serve to maintain their vertical alignment.

The new product can be fabricated to any size, with or without a side frame, depending upon the application.

Long Lasting Heating Coils and Exchangers

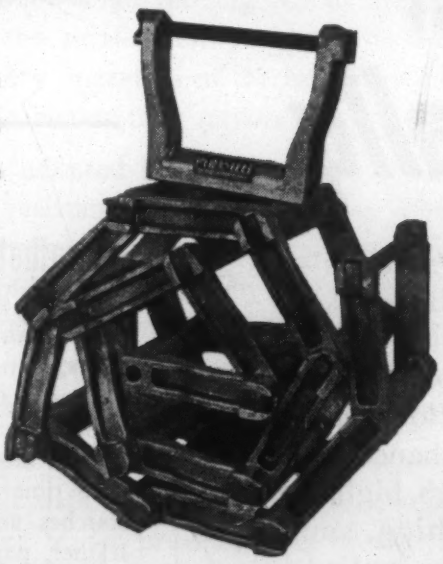
Tantalum heating coils that are claimed to possess several advantages over coils made of other material are now offered by *United Chromium, Inc.*, 100 E. 42nd St., New York 17. Heat exchangers are also available, utilizing the tantalum tubing. Both coils and exchangers can be obtained

HOT SPOTS require the use of *Pyrasteel* PARTS



PYRASTEEL Sprocket and section of Belt Conveyor . . . a typical high-temperature application with a record of exceptionally long service.

PYRASTEEL Drag Chains are widely used in the cement and allied industries. Even when immersed in molten clinker, they do not warp, break or oxidize.



When you need extra durability in high temperature applications, specify PYRASTEEL Parts. This chrome-nickel alloy provides maximum resistance to heat and corrosion at temperatures up to 2000° F., and it also resists corrosive gases and most concentrated or dilute commercial acids.

PYRASTEEL adds to the service life of refinery fittings, furnace parts, conveyor screws, and food and chemical processing equipment.

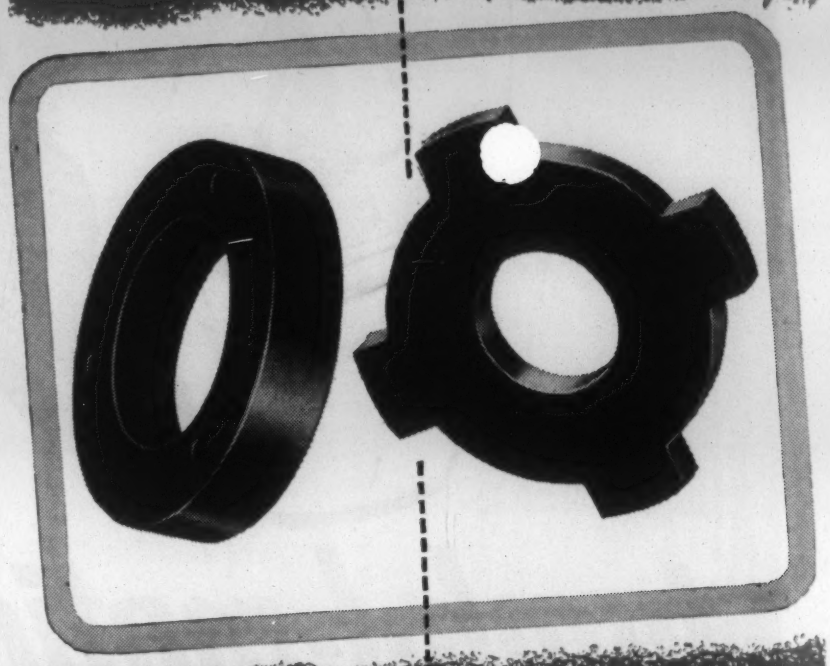
Write for PYRASTEEL Bulletin

CHICAGO STEEL FOUNDRY CO.

Kedzie Avenue and 37th Street • Chicago 32, Illinois

Makers of Alloy Steel for Over 40 Years

Every one IMPERVIOUS to hot corrosive liquids



MORGANITE SELF-LUBRICATING SEAL NOSES

— for high temperature, high pressure operation on all rotary equipment

Here's the seal element you can depend on for long, trouble-free service in the presence of high temperatures, corrosive chemicals, oil, water and other fluids. Morganite provides a self-lubricating, leaktight running seal recommended for handling foodstuffs, beverages, paraffin, hot water and other liquids. Typical applications include food mixers, washing machines, food and enameling oven conveyors, fuel pumps, and water circulating pumps for automotive, marine and aircraft engines.

NON-CONTAMINATING .. they impart no taste or odor

CHECK UP NOW on Morganite self-lubricating, self-lapping and polishing carbon parts. Cut maintenance and production interruptions, increase the service life of your products with Morganite bearings, vanes, rings, seal elements and special parts. See our illustrated catalog in Sweet's File for Product Designers or write for complete engineering data.

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Manufacturers of CARBON MOTOR and GENERATOR BRUSHES, CARBON PILES and SELF-LUBRICATING CARBON SPECIALTIES

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Give Finer Surfaces at Least Cost

Automatically

Tumb-L-Matic's "Pushbutton" Processes—equipment, compounds, and techniques—AUTOMATICALLY impart that finer, touch-and-sell finish to your plastic products...at substantial savings. They provide closer control over finishing operations...enhance the saleability of your products through higher-quality definning, cutting, smoothing, and lustering operations. When properly applied, they eliminate costly buffing...free vital manpower for more productive work.

Tumb-L-Matic's extensive line of machinery and compounds, backed by a quarter-century of experience with a wide and broadening range of materials, permit the "tailored" selection of cost-saving *standard* processes to fit your particular products and production layout.

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Write and tell us about your product finishing problems...or SEND A SAMPLE FOR COMPLETE ANALYSIS AND RECOMMENDED FINISHING PROCESSES

TUMB-L-MATIC, INC.

FORMERLY LUPOMATIC INDUSTRIES, INC.

4510 BULLARD AVENUE • NEW YORK 70, N. Y.

New Materials and Equipment

in standardized units or made to order.

Both products, according to the company, promise durability. Tantalum is virtually acid-proof, resistant to all of the acids commonly found in the plating room, except straight hydrofluoric acid. It is especially recommended for chromium plating solutions that are so severe on the lead coil or special alloy heat exchangers generally used. The advantage here is not only long life, but also freedom from the corrosion and sealing that form heat-insulating coatings and present a maintenance problem. While excellent for acid solutions, tantalum should not be used in alkaline baths where ordinary iron or steel serves quite well.

Tantalum tubing also affords the advantage of making possible substantial savings in both heating and cooling. Tantalum possesses heat conductivity superior to any lead alloy and better than steel. The great strength of the metal permits the use of tubing with thin walls, with no allowance necessary for loss of strength due to corrosion. Good conductivity plus thin walls provide fast heat transfer with minimum lag, and, therefore, much closer regulation of bath temperatures.

Synthetic Self-Emulsifying Wax

A new synthetic wax, designed to duplicate Japan wax in all essential characteristics, is currently offered by *Concord Chemical Co.*, Moorestown, N. J.

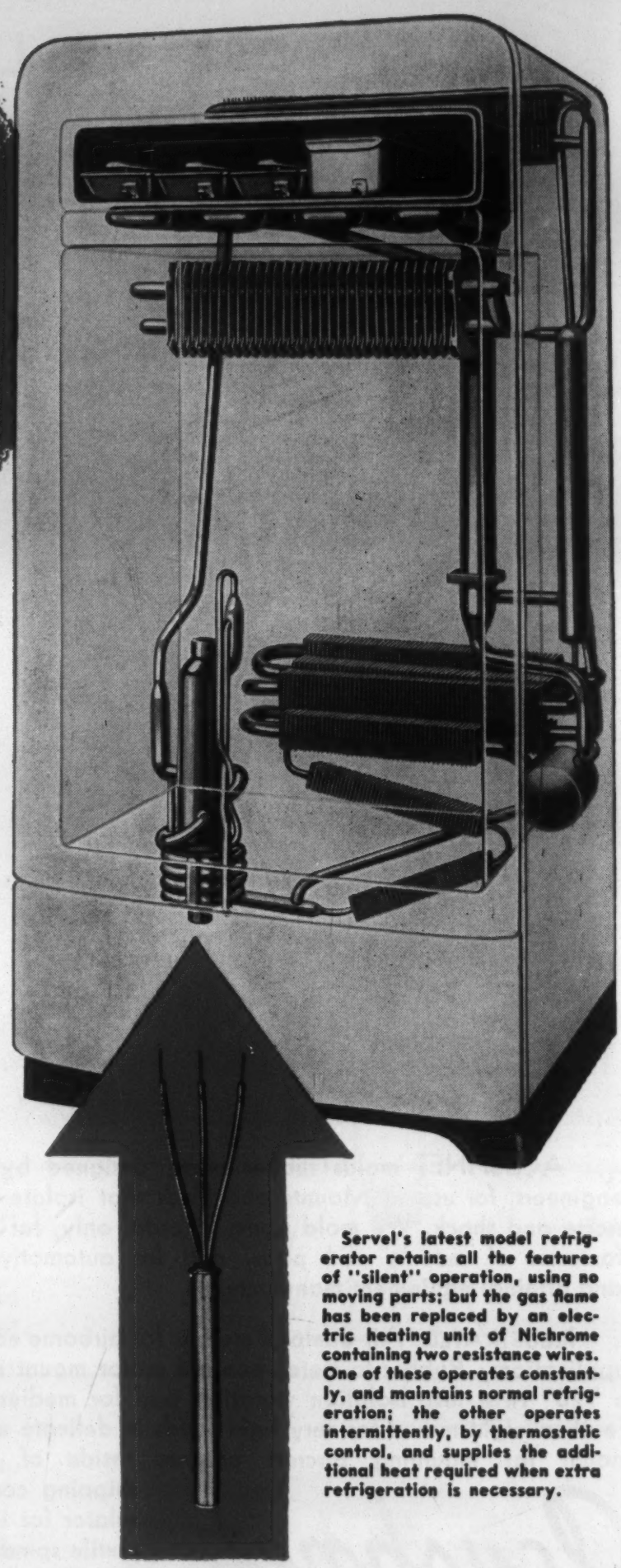
Self-emulsification, the unusual property of the new wax, helps to cut costs and save time in the manufacture of plastic starches and in the finishing of textiles, leather, paper, thread and cord.

A lasting emulsion can be made from the new wax by melting the wax and adding hot water. Under the name Aquawax, the new product is one of several waxes developed by the company as replacements for high-priced and hard-to-get imported waxes.

Traveling Head Grinder for Armor Plate

A new conception and approach to the problem of face grinding is claimed in the Mercury Series E-20 traveling head grinder, developed by *Mercury Engineering Corp.*, Milwaukee. Designed for the

Servel goes electric with NICHROME*



Servel's latest model refrigerator retains all the features of "silent" operation, using no moving parts; but the gas flame has been replaced by an electric heating unit of Nichrome containing two resistance wires. One of these operates constantly, and maintains normal refrigeration; the other operates intermittently, by thermostatic control, and supplies the additional heat required when extra refrigeration is necessary.

Now the famous silent Servel refrigerator operates on electricity. In the new refrigerator, a simple electric heating element provides heat for operating this absorption-type system. Just plug it in, and the new Servel goes to work . . . provides the *soundless* performance for which it is famous.

Since cold is obtained without a single moving part by means of heat applied to the system, the small heating element is the vital part of the new Servel. Every operation of the refrigeration cycle, indeed, depends upon the heater unit *staying on the job.*

Because of this, Servel has adopted heating elements made with Nichrome—the electrical resistance alloy that is the very heart of quality appliances everywhere. Remarkably resistant to high heat and corrosion, and able to retain its physical and electrical properties despite thermal shock resulting from intermittent operation day in and day out, Nichrome assures Servel of efficient operation and a lifetime of dependable service.

Whatever *your* requirements for electrical resistance material, it will profit you to consult with us. In addition to world-famous Nichrome and Nichrome V, we produce over 80 alloys to meet the varied needs of the electrical and electronic fields. Although strategic materials and the alloys we make from them are on strict allocation at the present time, we'll be pleased to serve you to the best of our ability.

SPECIAL PURPOSE ALLOYS SINCE 1899 — D/H — TRADE MARK REG. U. S. PAT. OFF.

Driver-Harris Company

HARRISON, NEW JERSEY

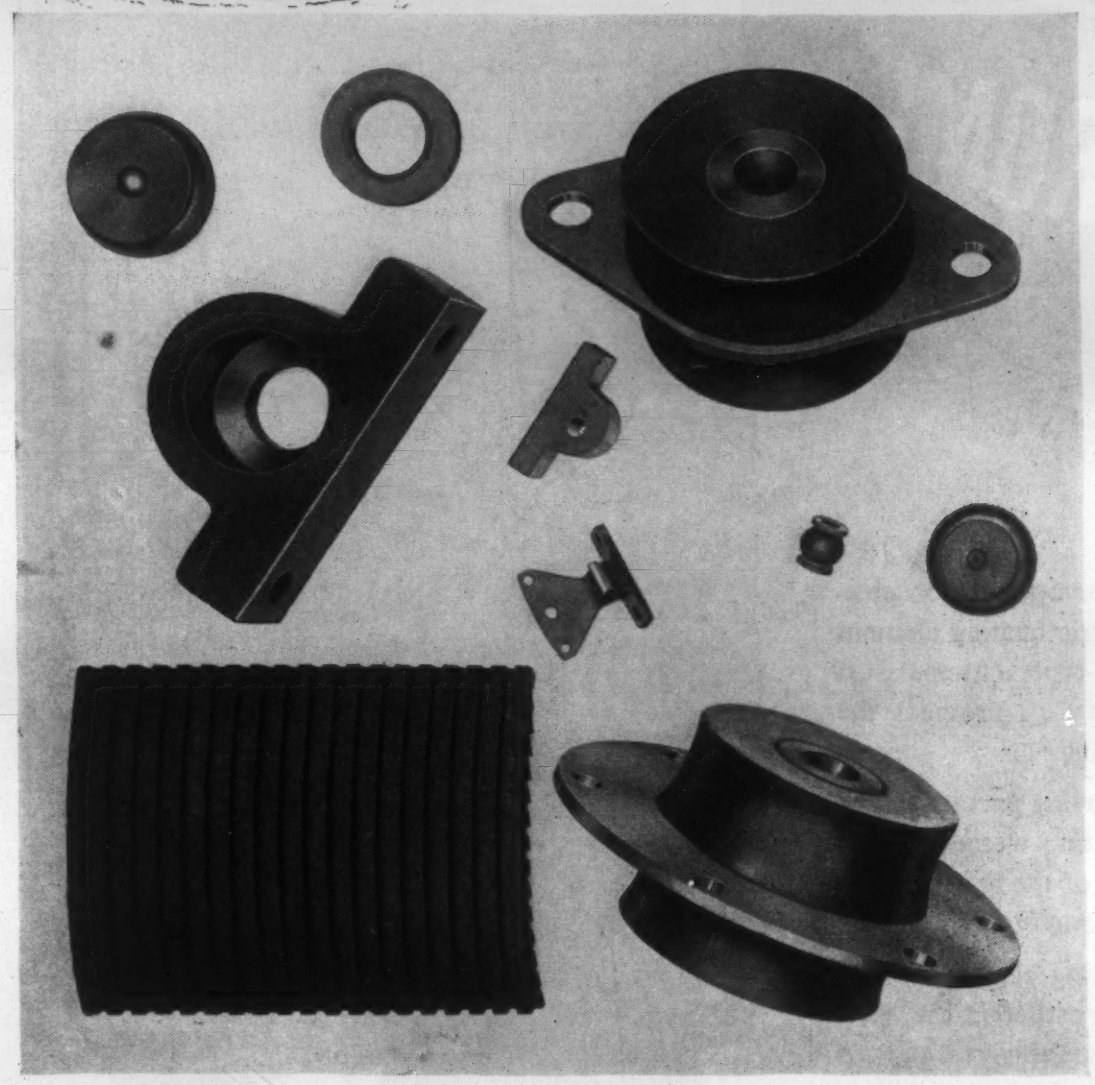
BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

* T. M. REG. U. S. PAT. OFF.

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

Rubber Parts molded for Mounts that ISOLATE VIBRATION



ACUSHNET molds rubber parts, designed by customers' vibration engineers, for use in Mounts and Pads that isolate vibration or suppress noise and shock. We mold parts, to order only, for many leading manufacturers of mounts and pads, and for automotive, aviation, electrical and original equipment manufacturers.

ILLUSTRATED. Air-damped mounts for airborne equipment and military applications; Rubber-to-metal bonded motor mount required to withstand a 720° twist test; Isolation vibration pad for medium weight machinery; Featherweight mount for very light loads in delicate equipment; Disc type mount for mounting aircraft engines inside of hermetically sealed shipping containers; Spindle insulator for isolating vibration in textile spindles.

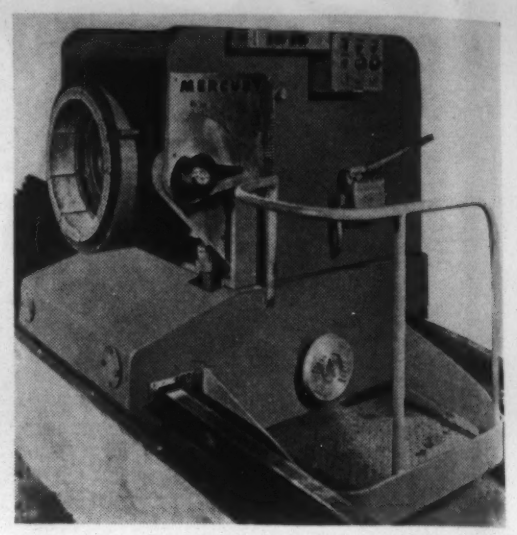
Acushnet
PROCESS COMPANY
New Bedford, Mass., U. S. A.

ARMY E NAVY

Rubber Handbook sent on request

Address all communications to 750 Belleville Ave., New Bedford, Mass.

New Materials and Equipment



This traveling head grinder reduces initial and maintenance costs to a new low.

grinding of armor plate, the unit offers new opportunities in grinding edges, angular surfaces, compounds and bevels, as well as machining pads on heavy castings 20 ft or longer.

Because of the unique factors, the new grinder eliminates the expensive and hard-to-maintain traverse bed common to conventional traveling head grinders. Both initial and maintenance costs are reduced to a new low.

Running on self-powered precision rollers along rails machined to precision tolerances and equipped with built-in leveling devices, the Series E-20 employs a 20-in. face-type grinding wheel mounted on a head which tilts from horizontal to full verticle, and has complete mobility with traverse rate continuously variable. Two or more grinders can operate simultaneously on a single set of rails.

Super powered for continuous production, the 20-hp motor and heavy duty precision spindle assembly are mounted within rigid trunnions and arranged to feed in and out through 7-in. range, utilizing planetary gear driven motor reducer in combination with precision lead screw. Various increments of feed are accomplished electrically.

Vitreous Enamel Applied Directly to Ordinary Steel

A new development in protective coatings has been announced by *Strong Manufacturing Co.*, Sebring, Ohio. Called TI-LOC, the coating is a one-coat, white titanium vitreous enamel which can be applied directly to steel without the use of premium steel.

The new product is said to be of par-

"Mopping up" for momma

If your wife has one of the popular, new O'Cedar Cellulose Sponge Mops, take a good look at it. You will note that the cellulose sponge is bonded to a piece of canvas, which in turn is bonded to a metal plate. In each case, a 3M adhesive is used.

Working closely with O'Cedar engineers, 3M developed an adhesive specifically for their application. The adhesive had to be highly resistant to soaps and detergents, boiling water, and plain, old-fashioned "elbow grease." Moreover, the adhesive had to fit production line methods that turn out thousands of high quality mops, at low cost. The success of this adhesive—proved by manufacturer and consumer—is another tribute to the almost limitless versatility of 3M adhesives.

Scientifically engineered to each job, 3M adhesives, coatings and sealers are cutting costs, speeding production and improving products daily . . . in all industries!

See what adhesives can do for you . . .

Contact your 3M salesman. His expert advice is at your disposal. And for more information on adhesives, coatings and sealers, write 3M, Dept. 612, 411 Piquette Avenue, Detroit 2.

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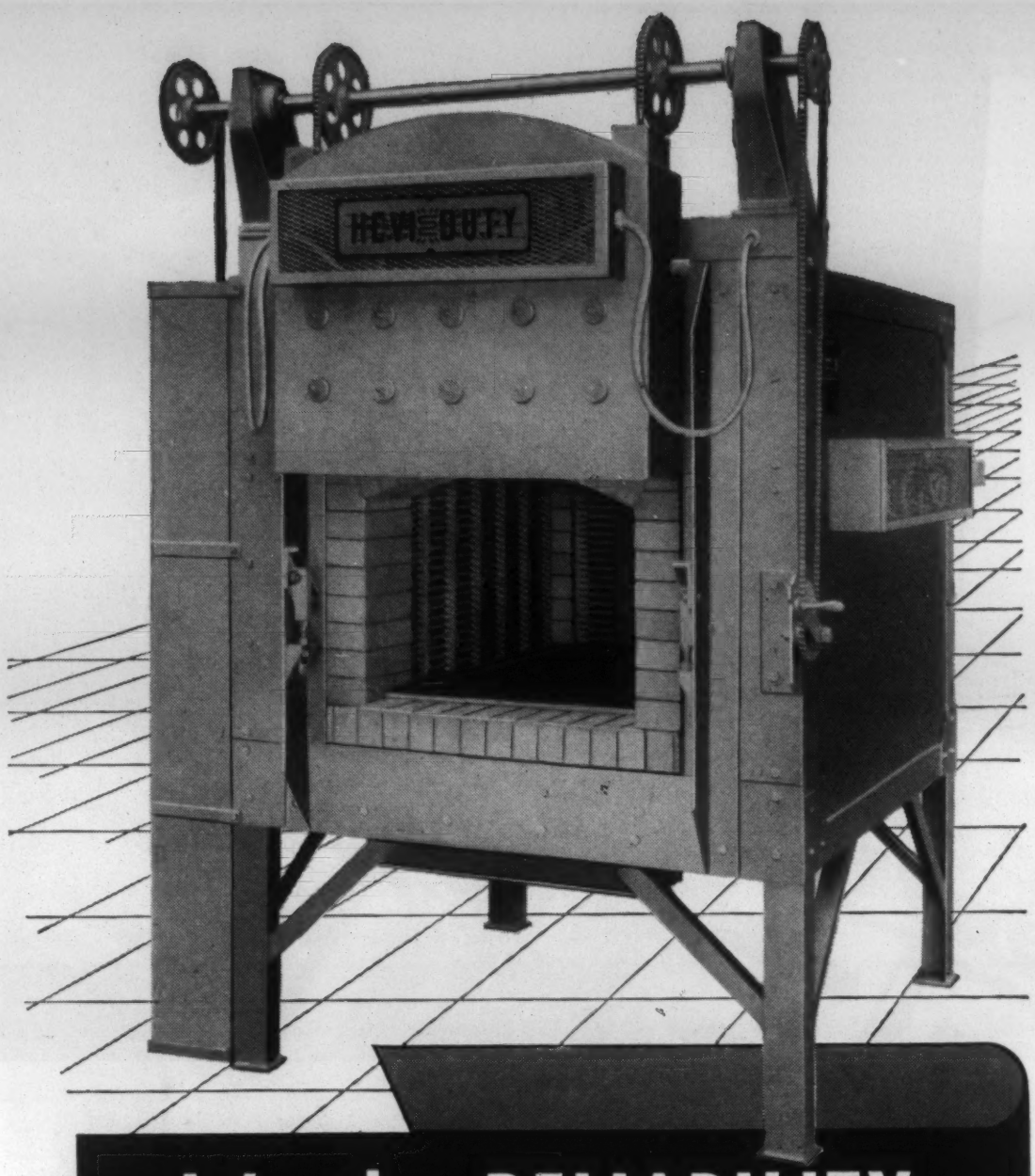
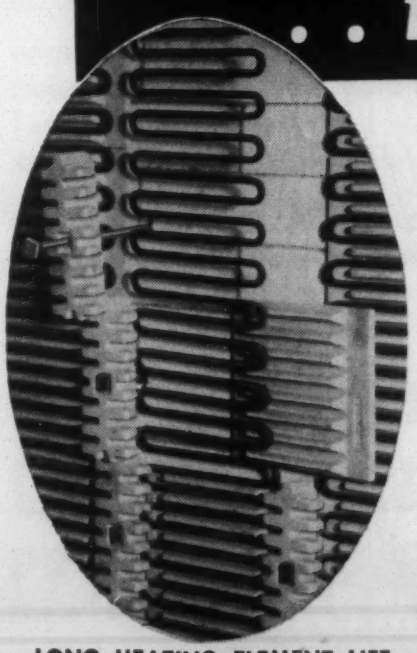


It's the RELIABILITY of HEVI DUTY Furnaces ... that COUNTS



LONG HEATING ELEMENT LIFE
Round rod return bend heating elements are adequately supported by radiant plates of high grade refractory material.

ADVANCED design, rugged construction and high quality materials are combined with years of furnace building experience to produce Hevi Duty box furnaces. Round rod heating elements and sturdy radiant plate element supports assure continuous performance under severe operating conditions. Users report that reliability and trouble free service are outstanding advantages of Hevi Duty furnaces.

Write for Hevi Duty Bulletin No. HD441

HEVI DUTY ELECTRIC COMPANY
HEAT TREATING FURNACES HEVI DUTY ELECTRIC EXCLUSIVELY
DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS
MILWAUKEE 1, WISCONSIN

New Materials and Equipment

ticular importance to manufacturers of products utilizing porcelain enamel as a finish, but it is also of significance to manufacturers of other metal products in that it offers many practical and new applications.

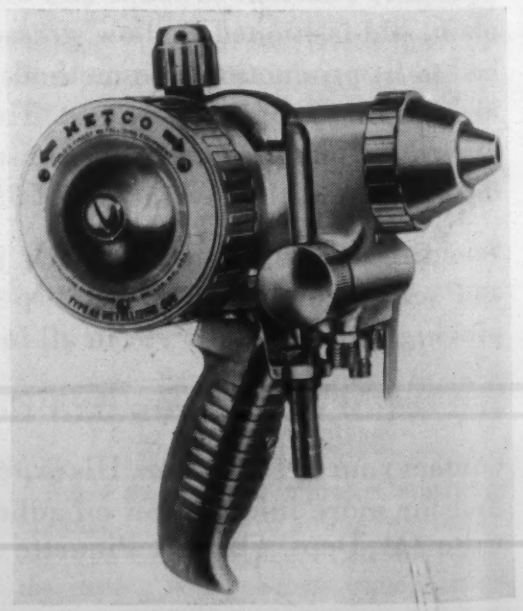
According to the manufacturer, the coating possesses all of the attributes common to standard vitreous enamel cover coats over ground coat, such as permanence of color, acid resistance, scratch-proof and burn-proof characteristics. In addition, its improved adherence and thinness of coating incorporates a ruggedness which provides extreme impact resistance and flexibility.

One of the unusual features of TI-LOC is that it can be drilled, punched, sheared and sawed in its finished state. This permits on-the-job fitting in the architectural field, for example, where previously panels had to be custom designed and fabricated.

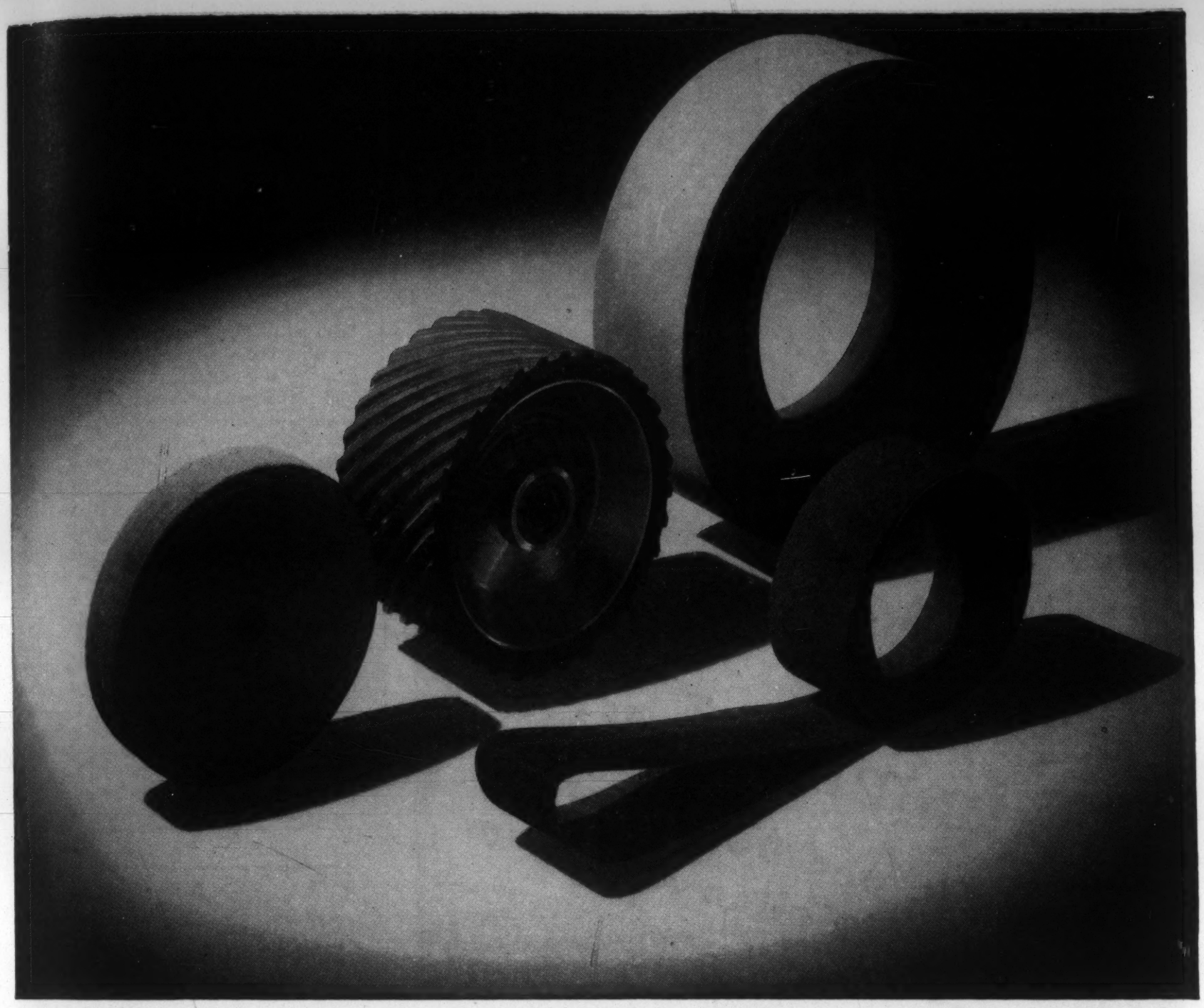
Metallizing Guns Spray at High Speeds

Two new metallizing guns have recently been announced by *Metallizing Engineering Co., Inc.*, 38-14 30th St., Long Island City 1, N. Y. The new guns, the Metco Type 4E for machine element work, and Type 5E for corrosion protection coatings, are said to develop the highest spraying speeds yet available in guns designed for hand-held operation.

The new products provide the nearest thing to automatic operation yet devised, according to the manufacturer, since they



This metallizing gun, Type 4E, is designed to spray all wires from 20 B&S gage to 1/8 in. in any metal.



Impartial advice . . .

That's what you get when you call your CARBORUNDUM representative for information on abrasives. He's a specialist who can recommend from a *complete* abrasive line. If you're using a belt where a wheel would do the job better, he will tell you so since he sells a *complete* line of abrasive products.

Furthermore, he is posted on all new methods and improvements throughout the entire field of abrasives—a specially important factor to you if your production requirements change frequently. For instance, he'll bring you improved products such as CARBORUNDUM's "61" Contact Wheel (illustrated above), with the "milling cutter" design that raises the practicability of belt grinding to new levels.

For real results in all abrasive applications, see your CARBORUNDUM representative. See him soon . . . and often.

Only CARBORUNDUM

TRADE MARK

makes ALL Abrasive Products . . . to give you the proper ONE

"Carborundum" is a registered trademark which indicates manufacture by The Carborundum Company, Niagara Falls, N.Y.

80-38

This is a high chrome alloy — 24% chromium and 12% nickel — an excellent alloy for meeting the conditions imposed when handling molten aluminum. As you can see the casting is approximately 6 inches in diameter — not a big casting as many Duraloy products go but indicative of what we can do in the way of small castings.

Our experience in this business of high alloy castings goes back to 1922 and we also pioneered work in the centrifugally cast high alloys which we inaugurated back in 1931. So we have much to offer those requiring chrome-iron, chrome-nickel and nickel-chrome castings. Plenty of experience, skilled metallurgists and foundrymen, modern testing and analytical facilities, and one of the most up-to-date and fully equipped high alloy foundries in the country.

We'll be glad to help (1) in the design of the part you need to produce the strongest casting and (2) to advise in the alloying elements to produce the most durable casting.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • Eastern Office: 12 East 41st Street, New York 17, N.Y.

Detroit Office: THE DURALOY COMPANY, 805 New Center Building

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New Materials and Equipment

incorporate a patented jet siphon principle in the gas head which automatically compensates for variations in gas pressure as high as 10 lb, and provides a steady, unvarying flame which produces uniform coatings at lower cost than previously possible. The new guns also feature automatic control of wire feed, which compensates for kinks in the wire, reel stand drag, etc.

Designed to spray all wires from 20 B&S gage to 1/8 in. in any metal, carbon steels, monels and bronze at speeds up to 40% faster than previous models, the 4E gun is expected to cut machine part repair and salvage costs as much as 85 to 90%. Type 5E is claimed to be the first gun specifically designed for high-speed spraying of the softer metals, such as zinc and aluminum, and for protection of equipment and structures against corrosion for periods ranging from 20 to 30 years. It also sprays 3/16-in. wire and will deposit as much as 55 lb of zinc per hr, aluminum 15 lb per hr.

Electronic Micrometer for Rapid, Accurate Measurements

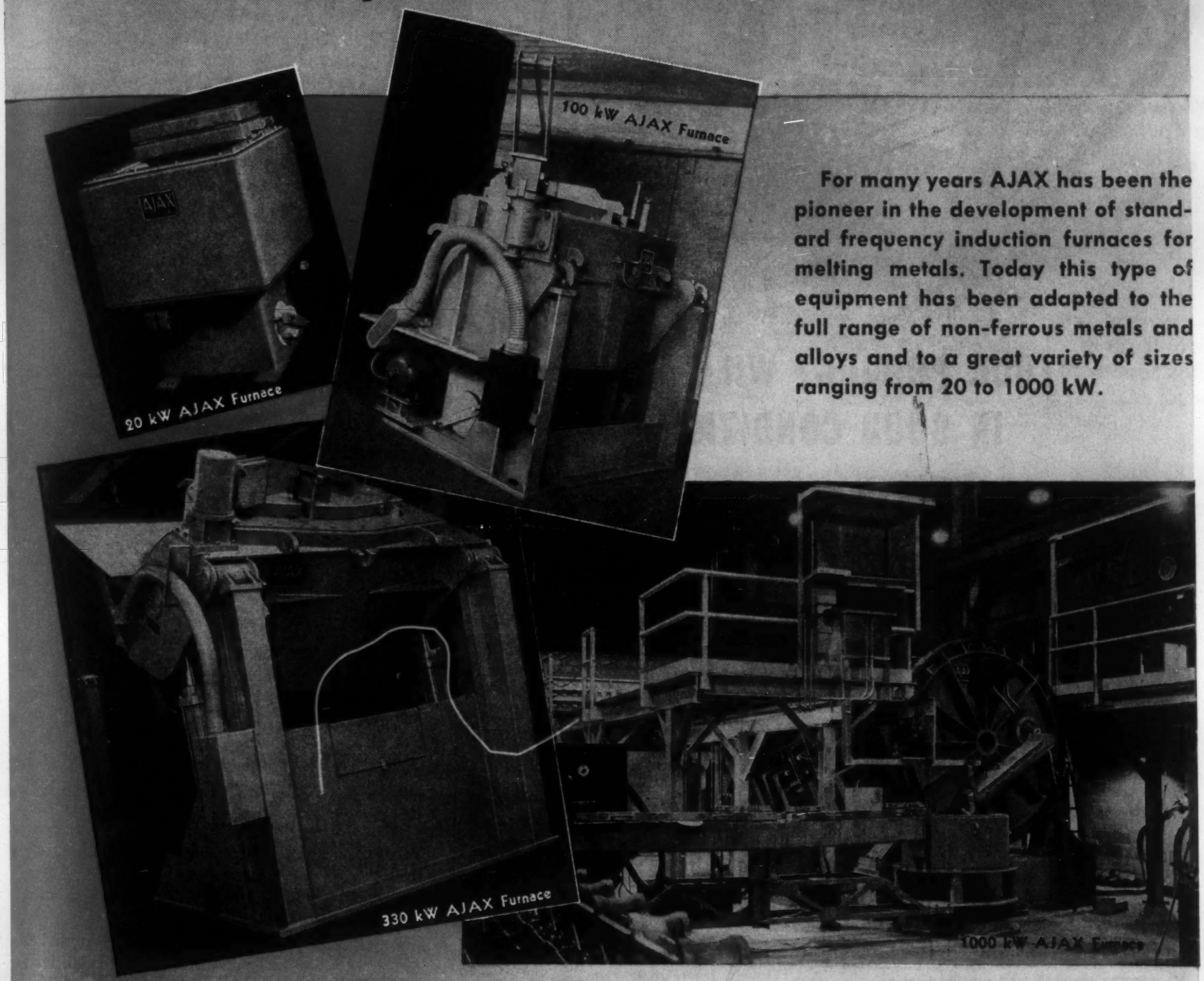
Rapid and accurate measurements to a tolerance of 0.00002 in. are claimed for the new electronic micrometer offered by *J. W. Dice Co.*, Englewood, N. J.

The Carson-Dice micrometer can be used for rapid measurement of machined

This electronic micrometer can be used for rapid measurement of machined parts, ball bearings, small assemblies and depths of counterbore.

parts, ball bearings, small assemblies and depths of counterbore. It can also be used to measure deflection in diaphragms, bi-metal elements, springs, bellows and similar applications requiring measurement without pressure. The unit is said to offer the only means to measure soft or compressible materials precisely. It can be applied to paper, foil, ribbon, rubber,

Yes! AJAX Induction Melting Furnaces are Versatile!



For many years AJAX has been the pioneer in the development of standard frequency induction furnaces for melting metals. Today this type of equipment has been adapted to the full range of non-ferrous metals and alloys and to a great variety of sizes ranging from 20 to 1000 kW.

AJAX Induction Melting Furnaces are now used for the following applications: Die Castings, Permanent Mold Castings, Sand Castings, Billets for Rolling and Extrusion, Recovery of Scrap, Galvanizing and Aluminizing of Steel and many others.

For special applications an Automatic Electromagnetic Pump allows continuous feeding of molten metal into the molds as they move past. Hand ladling is eliminated. Temperature, of course, is also automatically controlled and there is no chance of overheating the bath at any time during the melting cycle.

WRITE FOR FURTHER INFORMATION

AJAX ENGINEERING CORP., TRENTON 7, N. J.

AJAX TAMA-WYATT

INDUCTION MELTING FURNACE

AJAX ELECTRO METALLURGICAL CORP., and Associated Companies
AJAX ELECTROTHERMIC CORP., Ajax Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax Wyatt Induction Furnaces for Melting

"YOUR PRODUCT WILL ARRIVE IN GOOD CONDITION"—

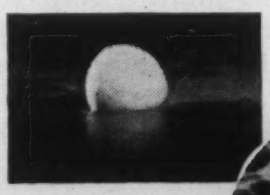
PACKED IN RUBATEX

Labels warn but do not protect. Pack your product in RUBATEX and you provide essential cushioning which assures "arrival in good condition".

RUBATEX is a closed cellular rubber composed of hundreds of thousands of individually sealed balloon-like chambers in every square inch. Each chamber retains inert nitrogen under pressure and is completely surrounded by a membrane of live rubber. This structure forms a dense resilient cushion which literally smothers impact.

RUBATEX cannot absorb moisture. It has high insulating value—is resistant to oxidation and is rot and vermin proof. It has good compressive strength and is extremely light in weight—only 4½ pounds per cubic foot.

The amazing cushioning and shock-absorbing qualities of RUBATEX closed cellular rubber recommends it as a packing material to better protect your product *all the way*. Most package applications can economically be cut from sheet stock. For further information, write for Catalog RBS-12-49, Great American Industries, Inc., RUBATEX DIVISION, BEDFORD, VIRGINIA.



Dropped from a height of more than one hundred feet, this egg bounced off a three-inch-thick pad of RUBATEX closed cellular rubber without breaking. RUBATEX absorbed and dissipated the impact shock equal to a velocity of more than sixty miles an hour.

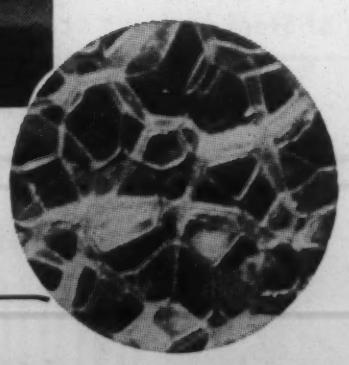


Photo-micrograph of RUBATEX closed cellular rubber shows the tiny individually sealed balloon-like chambers which retain inert nitrogen under pressure.

RUBATEX®

CLOSED CELL RUBBER

FOR GASKETING • CUSHIONING • SHOCK ABSORBING • VIBRATION DAMPING

New Materials and Equipment

felt, plastic sheets, linoleum, photographic film and textiles with equal ease.

An electronic circuit used in conjunction with an extremely accurate micrometer head permits pressureless measurement and eliminates feel as a source of error. The circuit is sufficiently sensitive to give positive on and off indications with only 5 millionths of an inch displacement at the contact. Several models are available with different work capacities for measurement on compressible or non-compressible materials, either conducting or non-conducting in nature.

Cutting Compound for Stainless Metals

A new cutting compound, called C-5, for machining stainless steels and other alloy metals, has been introduced by *Felt Products Manufacturing Co.,* 1504 Carroll Ave, Chicago 7.

The use of the new compound by metal working industries is an extension of its successful uses with metals in high temperature thread compound applications by leading refineries and utilities.

C-5 is said to prevent galling and pitting of metal surfaces, increase tool life, permit higher cutting speeds and assure greater accuracy through maintenance of uniform cutting temperatures. It is recommended for boring, turning, tapping, threading, broaching, grooving, sawing and other metal working operations.

The compound has the same high temperature and pressure resisting qualities as Fel-Pro's C-5 thread compound, which is claimed to withstand temperatures up to 1800 F.

Flux-Contained Brazing and Silver Soldering Pre-Forms

PresSint Products, Lyndhurst, Ohio, is currently offering to industry flux-contained brazing and silver soldering pre-forms covering a broad range of metals and combinations.

A PresSint pre-form is designed for one particular application. An alloy and a flux best fitting the job requirements are compounded in a ratio, and a pre-form

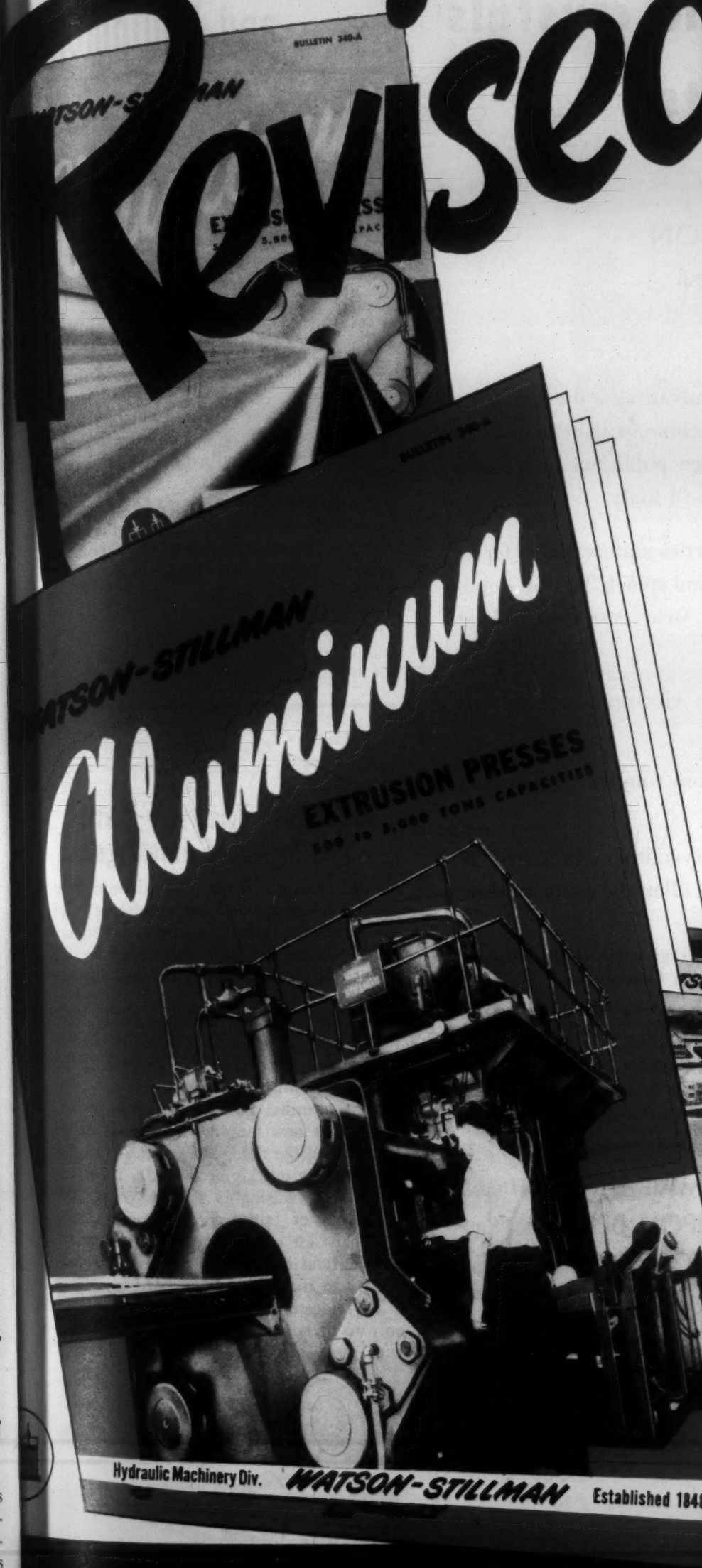
Revised . . .

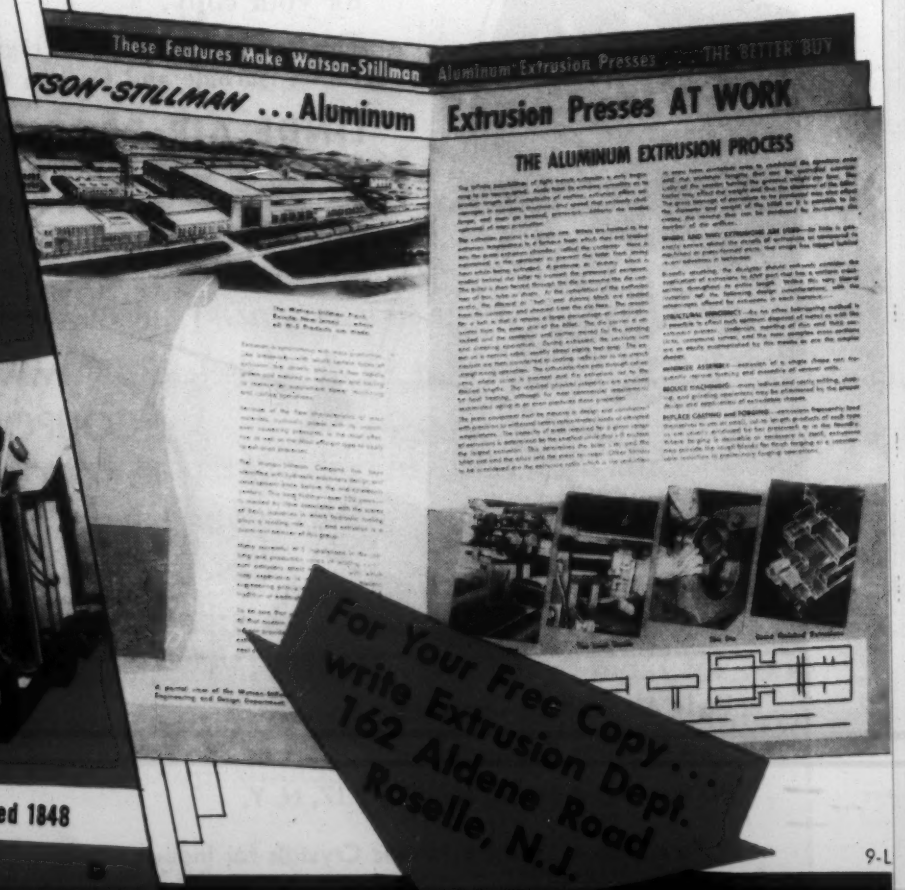
and Ready–for you

Here's a fact-packed Bulletin that was revised *before* it was printed! Not the contents—which are still up to the minute—but the *quantity* of the printing order had to be greatly increased to meet the flood of requests that came about through our announcement of this new piece of product literature in recent issues of your favorite technical journals.

Paper Problems are now well in hand and copies of the new W-S Aluminum Extrusion Press Brochure will be in the mails starting *Monday, November 26th,* to those whose requests are already in. Thanks for waiting.

Want a Copy? Write today, if you haven't already done so, for this resumé of light metals extrusion equipment . . . methods, applications, machine capacities, time-saving set-up features and controls. It will help you assess the many advantages of in-plant extrusion—flexible, fast, economical production of your non-ferrous shapes . . . elimination of costly inventory and crippling shortages . . . stabilization of productive flow and labor force requirements.





For Your Free Copy . . . write Extrusion Dept. 162 Aldene Road Roselle, N.J.

9-L

HYDRAULIC MACHINERY DIVISION **WATSON-STILLMAN** ESTABLISHED 1848

Factory and Main Office: Roselle, New Jersey

Branch Office: 228 N. LaSalle, Chicago, Ill. • Manufactured in Canada by—Canadian-Vickers, Ltd., Montreal

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Akron, Ohio	Watson-Stillman Co.	Portland, Ore.	Machinery & Tool Supply Co.
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Dallas, Texas	M & R Sales Co.	Spokane 8, Wash.	Machinery & Tool Supply Co.
Denver 2, Colo.	Overgard Machine Tool Co.	St. Paul 4, Minn.	Anderson Machine Tool Co.
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Use *Linde* Trade-Mark synthetic crystals at critical spots

to

WITHSTAND HEAT
OVERCOME FRICTION
RESIST CORROSION
REDUCE WEAR

These remarkable materials have definite advantages for key parts on which successful operation of a whole machine or instrument can depend. Data on LINDE crystals has just been published in a folder full of ideas for every design engineer. You will find:

★ A quick reference tabulation of properties and available forms of "Linde" synthetic sapphire, ruby, and spinel. Typical applications of these crystals where friction, wear, corrosion, or heat is a problem.

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★ Valuable data on calcium and cadmium tungstate phosphors for radiation detection.

"'Linde' Synthetic Crystals For Industry" is available now . . . just fill in the coupon below for your copy.

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation.

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MAIL THE COUPON BELOW FOR THIS **FREE** FOLDER

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New Materials and Equipment

shape, to yield optimum end results. Weight of the flux-contained pre-form is controlled to milligrams.

Advantages over conventional flux and alloy methods of metal joining claimed by the company are:

Quality—Uniform, metered quantity of alloy, with accompanying uniform, metered quantity of flux assures uniform results.

Production—Pre-forms are ideally suited to oriented automatic feeding by vibrator or other devices, and can be used with flame, atmosphere furnace, or induction heating.

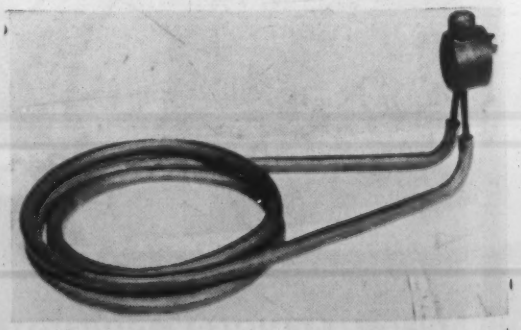
Costs—Material efficiency is appreciably increased. Moving the skill requirements from the production line to the laboratory offers significant cost savings in the higher production operations.

Redesigned Immersion Heaters Offer Increased Advantages

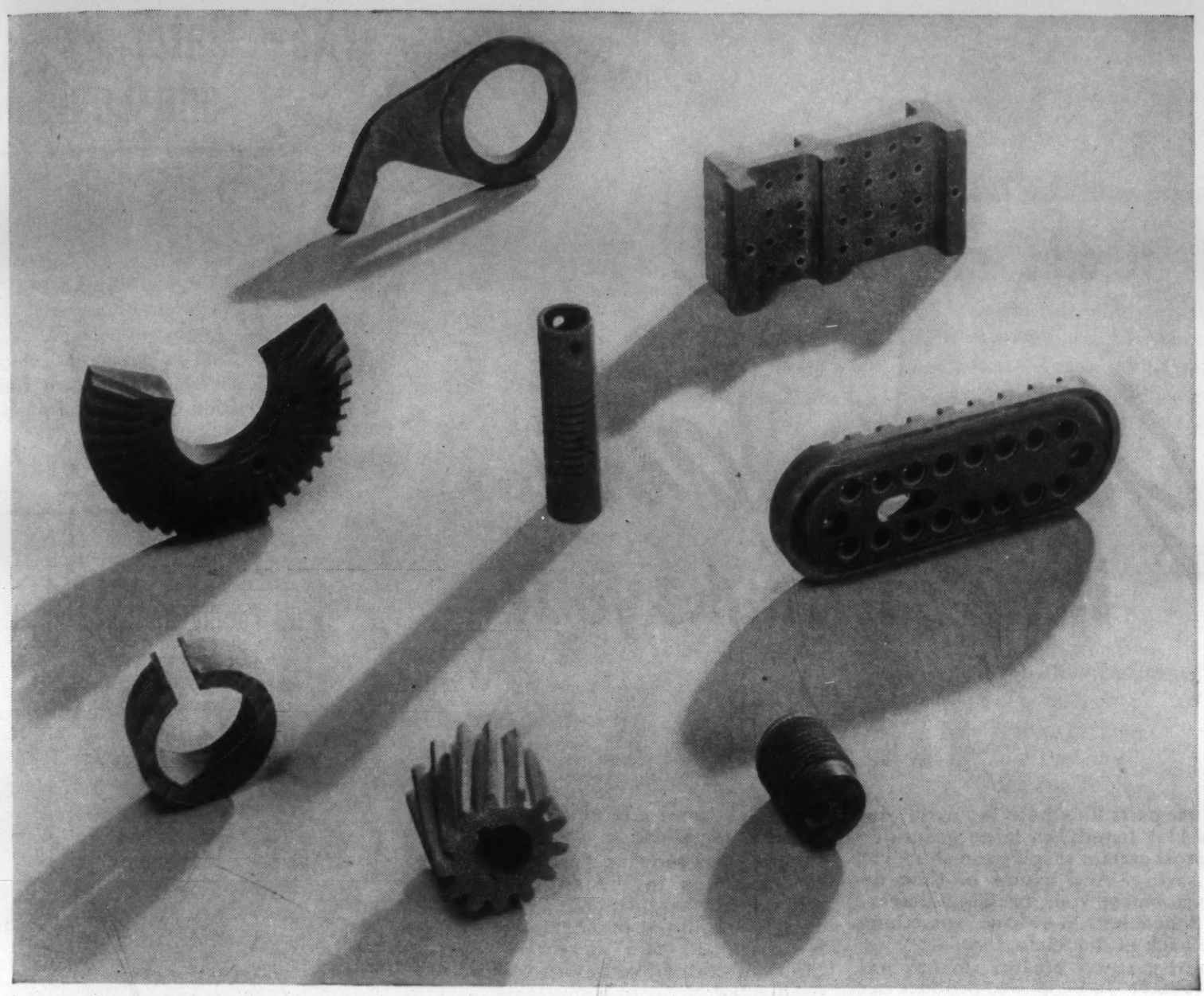
The redesign of two Calrod immersion heaters for nickel and copper plating baths and for mild sulfuric acid and chromium plating baths has been announced by the Industrial Heating Dept., *General Electric Co.*, Schenectady 5, N. Y.

Greater flexibility and portability have been incorporated in the new units, according to company engineers, by replacing the old-style sealing cup with a new junction-box of terminal housing which is vapor-tight. The new terminal housing is easier to repair in the field, and relocation of the unit is more quickly accomplished. In addition, the housing is said to reduce the possibility of faulty connections, and the terminals are readily accessible by removing the housing cover so the terminal connectors to the leads are exposed.

To relocate the heater, the operator has only to remove the cover, disconnect the wire from the heater, place it wherever



This Calrod immersion heater can be used for nickel and copper plating baths and for mild sulfuric and chromium plating baths.



versatile *Lamicoid*®
to relieve material shortage problems

Would you like to replace hard-to-get materials with one that has served in many applications . . . is tough and rigid . . . light weight . . . corrosion resistant . . . and possesses other features such as high impact strength, low moisture absorption, and heat resistance?

LAMICOID, a thermosetting plastic laminate, is the answer. Made from fillers — such as glass, nylon, paper or fabric with various resins—this versatile material can be produced with just the properties you need. LAMICOID will not only serve as a replacement, but in many instances be an improvement, too.

LAMICOID is supplied in sheets, rods and tubes, or fabricated into parts as you desire. We'll be glad to put our 58 years of experience at your service and give you more details on how LAMICOID can help you replace critical materials. Write today for complete details or send blue prints and specifications for a prompt quotation.

MICO ELECTRICAL INSULATION

MICA *Insulator* COMPANY

Schenectady 1, New York

Offices in Principal Cities

LAMICOID (Laminated Plastic) • MICANITE (Built-up Mica) • EMPIRE (Varnished Fabrics and Paper) • FABRICATED MICA

You Save... if we can make your TINY PARTS

If you use parts like these (up to ¼" dia. and to 1½" length) in large quantities, it is almost certain that we can show you a big saving. And assure on-time deliveries to meet your pressing defense work schedules. We have something unique back of that claim . . .

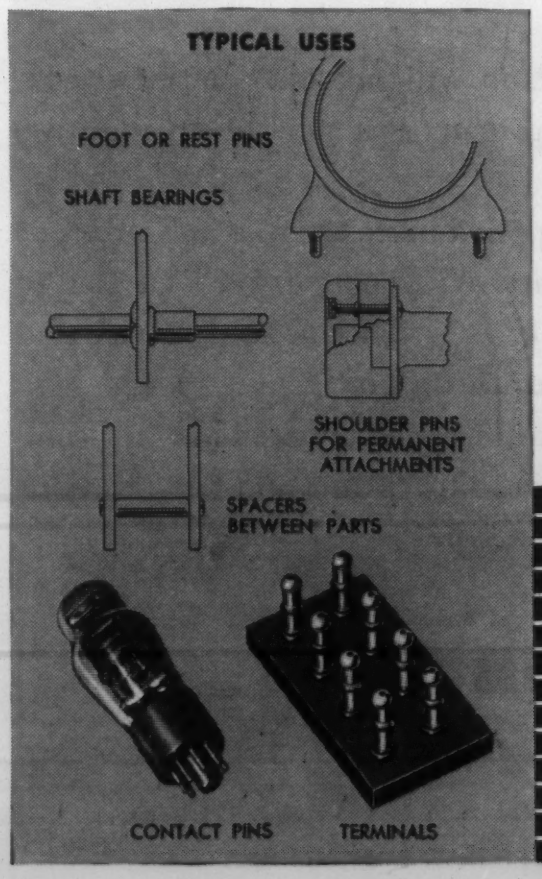
OUR QUOTE IS LOWER BECAUSE NOBODY HAS WHAT WE HAVE To be able to produce our famous Bead Chain to sell for pennies per yard, we had to develop our own equipment and method . . . our MULTI-SWAGE Method.

Instead of turning and drilling small parts from solid rod, or stamping and forming them, this advanced method automatically swages them from flat stock into precision tubular forms, with tight seams. By increasing the production rate many times, and eliminating scrap, this saves a large part of the cost by other methods.

FAMOUS USERS PROVE IT For years leading manufacturers in the radio and electronics field have depended on us to cut costs of millions of contact pins, terminals, jacks and sleeves. And, for pinlike parts and variations of bushings needed for *mechanical* purposes, we are the money-saving supplier to scores of prominent makers of toys, business machines, appliances, ventilators etc.

WHAT WE CAN MAKE Our Bead Chain MULTI-SWAGE Method permits parts to be beaded, grooved, shouldered, and of almost any metal. Generally, they should not exceed ¼" dia. or 1½" length. Catalog shows many *Standard Items* available in small quantity. *Special Designs* must usually be ordered in lots of a half-million or more, unless they are frequently re-ordered.

GET COST COMPARISON! Send blueprint or sample and quantity requirements. Our engineers will return an eye-opener on economy.



Let **BEAD CHAIN** make it by the

MULTI-SWAGE METHOD

I want this Catalog-Data Folder

The Bead Chain Manufacturing Co.
15 Mountain Grove St., Bridgeport, Conn.

Name, title.....

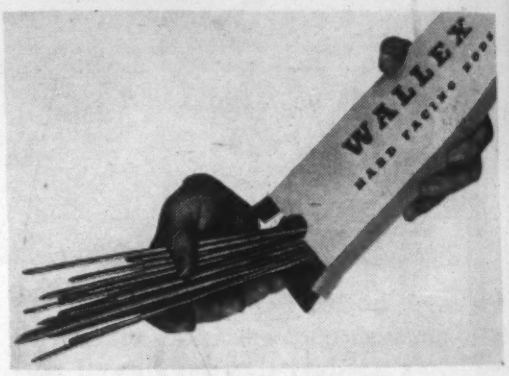
Company.....

Address.....

New Materials and Equipment

Hard Facing Rod for Many Uses

Wall Colmonoy Corp., 19345 John R. St., Detroit 3, has announced a new medium priced hard facing rod. An oxy-acetylene hard facing rod for abrasion resistance, Wallex is composed of chromium, molybdenum, manganese, silicon, carbon and iron.



This hard facing rod has been successfully laboratory and field tested during the past two years.

The new rod is claimed to have excellent abrasion resistance and good impact and corrosion resistance. Its hardness is 57 to 61 Rockwell C, and its melting point is 2375 F.

Available in sizes 3/16-in. dia, 8 to 12 in. long, ¼-in. dia, 8 to 12 in. long, and 5/16-in. dia, 8 to 12 in. long, Wallex can be used in the following applications: paper machine hog anvils; conveyor parts; coal screw conveyors; pipe line elbows; clay feeder shoes; grinder rings and rolling mill guides.

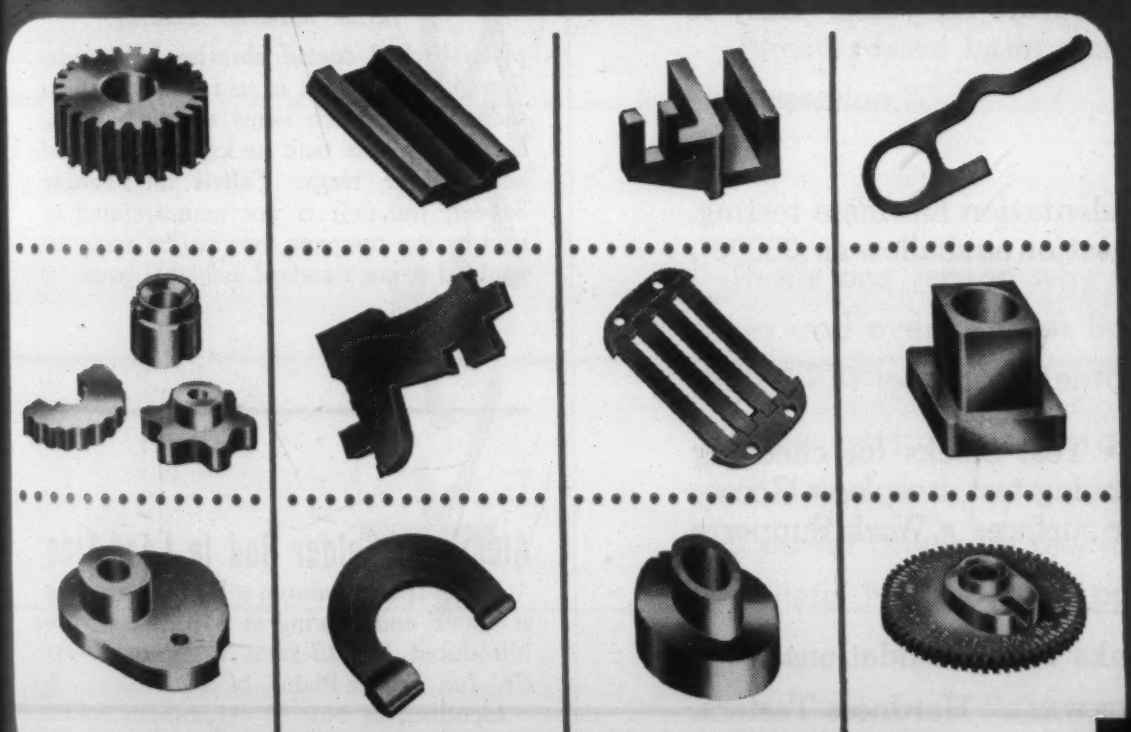
Sanding Unit Designed for Inside Diameter Work

Behr-Manning Corp., Troy, N. Y., division of *Norton Co.*, has announced the development of a coated abrasive belt sanding unit especially designed for inside diameter sanding, grinding and polishing work.

Adaptable to either free running or

NEED DEPENDABLE ALTERNATE MATERIAL including QUICK TOOL-UP and DELIVERY?

OILITE CAN HELP YOU NOW



Oilite Finished Machine Parts — with **NO** Machining

Here's how:

Oilite finished machine parts provide dependable replacements for bronze, brass, aluminum, cast iron, steel, and plastics. Frequently, replacements are permanent.

Oilite Material

Many Oilite raw materials, i.e., metal powders, are produced from by-products, readily available.

Tooling

Using Oilite finished machine parts, you save

Tooling programs
Tool Design
Machine Tools
Jigs and Fixtures
Cutting Tools
Gages
Floor Space
Skilled Manhours

Amplex type tools are, by comparison, inexpensive. Tool and die making facilities are available.

Delivery

Making Amplex tools generally requires only days or weeks and no additional machines.

Case Histories

Under conditions like today's we were in quantity production within six (6) weeks or less compared to eighteen (18) months by other processing.

Service

Our engineering and research covers a period of more than twenty (20) years in the production of Oilite metal powder products.

Home office personnel is augmented by a large staff of field engineers located in principal cities of the United States and Canada.

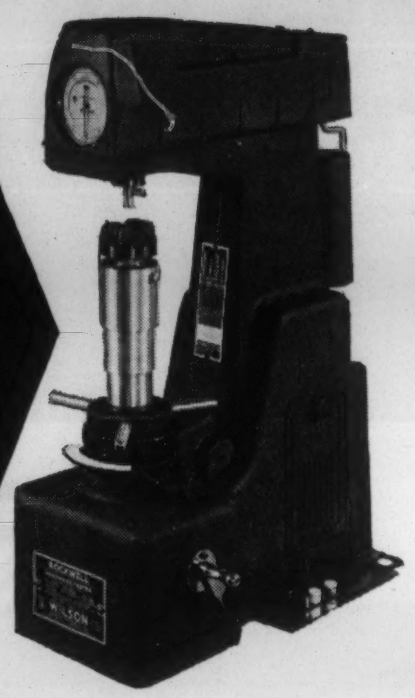
AMPLEX MANUFACTURING COMPANY
Subsidiary of Chrysler Corporation
DETROIT 31, MICHIGAN

OILITE PRODUCTS

OILITE PRODUCTS INCLUDE heavy-duty, oil-cushion, self-lubricating, ferrous-base bearings; Oilite bronze* and other nonferrous* bearings; self-lubricating cored* and bar* stock; permanent filters; and friction units.

Field Engineers and Depots throughout U.S. and Canada*

"ROCKWELL"*
...to be SURE
in
Hardness Testing



● You know the value of testing. You know the precision of "ROCKWELL" Hardness Testers. But is your present machine exactly suited for today's work? Or is it difficult to decide which model you need for new work in your plant or laboratory? To be sure, check the "ROCKWELL" line.

"ROCKWELL" HARDNESS TESTERS

For metals and alloys, hard or soft, flat, round, tubular, or odd shaped. Micrometric precision yet ruggedly built. Convenient controls. Four sizes.

"ROCKWELL" *Superficial* HARDNESS TESTERS

For shallow tests of razor blades, wire, tin plate, nitrided and lightly carburized steel. Accurate for years. Easy to operate. Variety of sizes.

TUKON

For microhardness or micro-indentation hardness testing. Automatic testing cycle. Indentation as shallow as .00005". Three models.

ACCESSORIES

"Brale" diamond penetrator • Test blocks for checking accuracy • Equitron for positioning test samples • Gooseneck Adapter for testing inner surfaces • Work Supports for rods, tubes, odd shapes.

Tell us your problem. Let us make recommendations.

Be sure. Buy "ROCKWELL" Hardness Testers.

**Trade Mark Registered*

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MECHANICAL INSTRUMENT DIVISION
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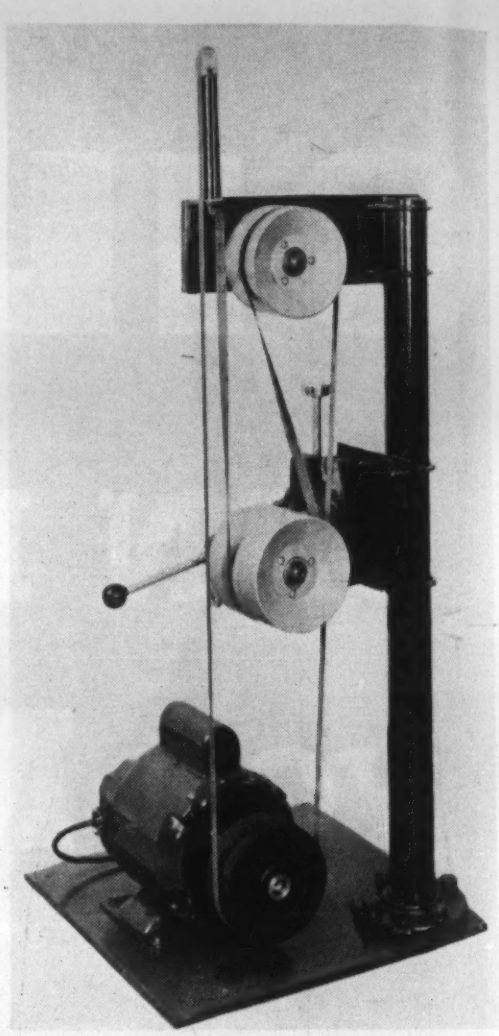
TRADE MARK

230-E Park Avenue, New York 17, N. Y.

New Materials and Equipment



This sanding unit is especially designed for inside diameter sanding.

platen-backed coated abrasive belt operations, this new unit is said to have proved successful on such items as bomb straps, horn rings, gas tank necks, tin snips and heavy shear rings. Called the Tongue Sander, the unit is not manufactured or sold by the company, but can be easily assembled using standard available parts.

Aluminum Solder Rod Is Lead-Free

A lead-free aluminum solder rod, melting at 400 F and flowing at 450 F, has been introduced by *All-State Welding Alloys Co., Inc.*, White Plains, N. Y.

Identified as No. 37 Aluminum Solder Rod, the new rod is said to open many new fields in a wide variety of industries due to the fact that it can be applied with ordinary soldering irons and that its performance is fully equal to that of higher melting point solders which must be applied by torch. While made especially for soldering iron applications, it can also be applied by any indirect heating method. It is used with All-State No. 37 Brazaloy flux.

Properly applied, the rod will withstand

Around the Clock

PRODUCTION AGAIN WITH SPENCER TURBOS

"In 1942 we moved to our present location and at that time we purchased 2 Spencer Turbine Blowers; these operated 24 hours a day, 7 days a week, until August 1945 and from then until now have operated from 4:30 in the morning 'til 6 o'clock some nights and many nights around the clock. They are both operating at the present time and have never been touched except for oiling. These blowers have been more than satisfactory for continuous operation."

RICHARD W. THORNE
BENNETT STEEL TREATING CO.
NEWARK, N. J.

That's one reason why more than 30 manufacturers of furnaces and ovens prefer Spencer and why the horse-power installed has increased tenfold in ten years.

Other reasons include quiet operation, without vibration—no special foundations, a wide range of standard sizes and special power drives for any location. Your next Turbo is described in Bulletin No. 126-A. Application data in Bulletin No. 107-C.

440-B

35 TO 20,000 C.F.M.; 4 OZ. TO 10 LBS.; 1/3 TO 1,000 H.P.

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

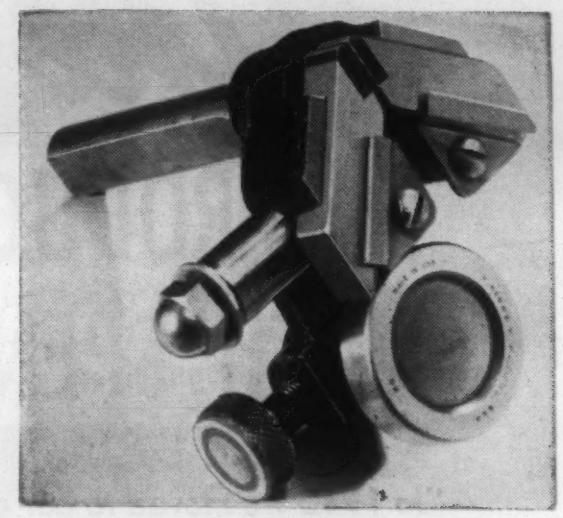
SPENCER
HARTFORD

Add EXTRA LIFE to machines and products!

WEAR-PROOF WITH

CARBOLOY®

CEMENTED CARBIDE



Keeps saws in line months longer!

Saw guides on saw setting machines took a terrific beating, resulting in costly downtime and maintenance. One saw manufacturer corrected this by wear-proofing the guide jaws with Carboloy Standard Blanks. Results: little or no downtime or maintenance!

Socket life increased 10 times!

Socket wrenches, used for driving hardened self-tapping screws, wore rapidly and slipped off the screw head, marring the product. The J. H. Williams Co. corrected this by using inserts of Carboloy cemented carbide. Life is increased at least 10 times over all-steel sockets; product scrap is greatly reduced.

Extra-accurate extra thousands of times!

Carboloy cemented carbide discs on the measuring faces of micrometers give greater accuracy, longer life. Scrap in the finished product is held down; frequent rechecking and refacing is eliminated.

WHAT better time to wear-proof with Carboloy cemented carbide than today, when machine and material conservation is so important?

Case history after case history proves that wear-resistant Carboloy cemented carbides combat wear, improve quality and increase the life of machine parts and products . . . increase it as much as 100 times in some cases!

Get your equipment rolling and keep it rolling for defense and essential civilian production. Wear-proof with Carboloy cemented carbide. Write, wire or phone:

CARBOLOY

DEPARTMENT OF GENERAL ELECTRIC COMPANY

11161 E. 8 Mile Street, Detroit 32, Michigan

"Carboloy" is the trademark for the products of Carboloy Department of General Electric Company.

New Materials and Equipment

pressures of 1000 psi. Applications include work on all types of aluminum except 24ST and also for work on aluminum to dissimilar metals, electric and neon signs, television and radio chassis, lighting fixtures and electronic equipment and instruments. Good matching color and good corrosion resistance are additional advantages claimed by the manufacturer.

Bright Zinc Process Improves Corrosion Resistance

Hanson-Van Winkle-Munning Co., Matawan, N. J., has announced a new bright zinc process, BSZ-300. A simple, economical method of producing bright to brilliant deposits directly from the plating bath, the process is said to provide greater corrosion protection for plated parts as well as sharply increased visual sales appeal. Parts plated by the new process are said to not only appear brighter, but to stay bright longer and have higher resistance to oxidation and tarnish.

The process requires no special equipment of any kind. It is based on the use of the BSZ-300 brightener as an additive to the regular cyanide solution. Requiring only low concentration in the plating bath and having a low consumption rate, BSZ-300 can be economically used right from the start.

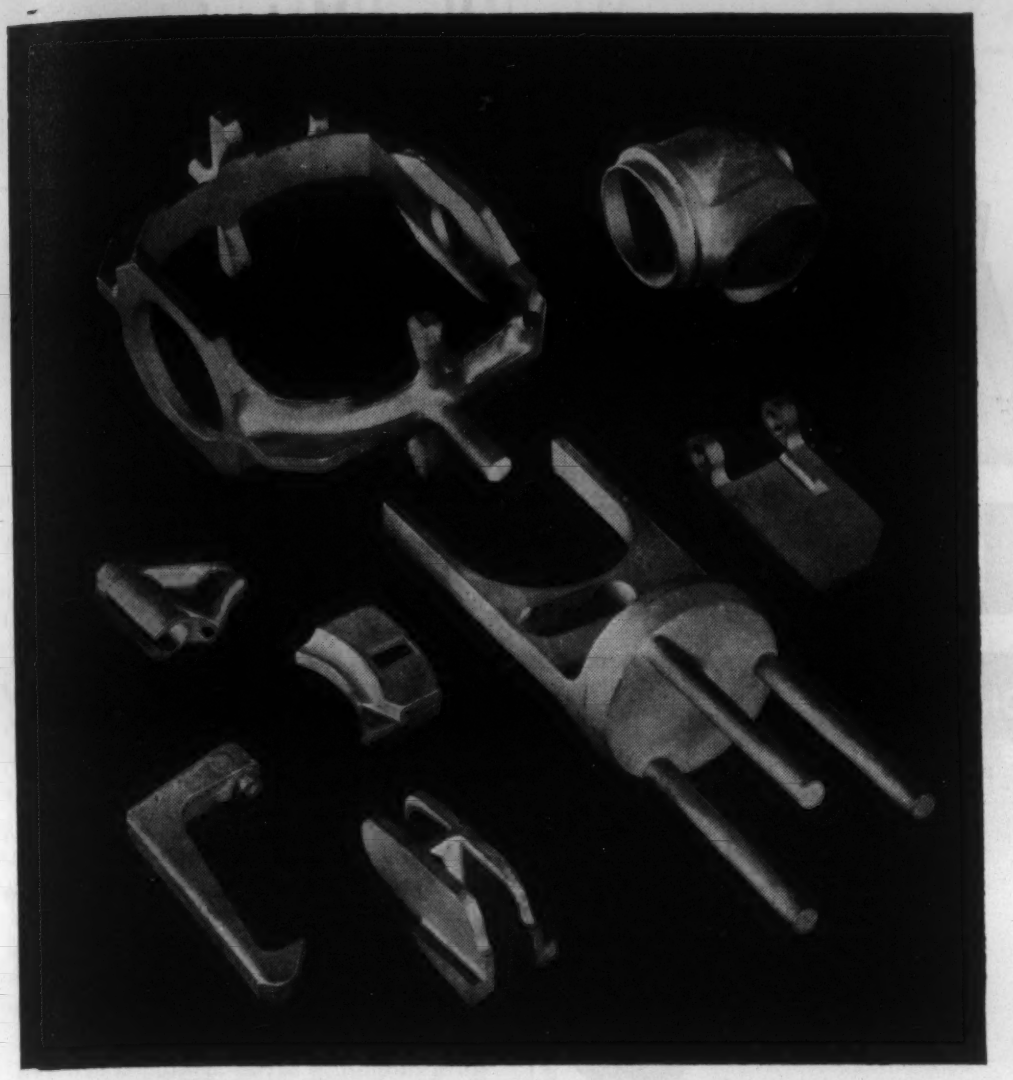
The solution can be used with equally satisfactory results over a broad range of current densities, and has exceptional tolerance for impurities. It readily accepts conversion coatings and can be soldered with comparative ease.

New Compound for Barrel Finishing

A special purpose chemical for barrel finishing brass, bronze, copper, gold and silver stampings, castings, machined and drawn parts is currently being offered under the trade name Blue Magic Compound No. 1 Double Strength by *Blue Magic Chemical Specialties Co.*, 2135 Margaret St., Philadelphia 24.

A highly concentrated paste for use in very small quantities, the compound

(Continued on page 140)

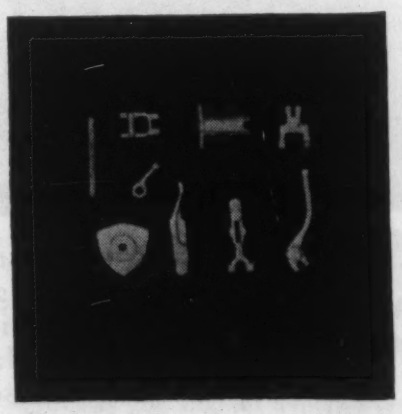


Accumet Precision Castings

for all industrial uses

With Accumet Precision Castings, Crucible has developed a process of producing precision investment castings in intricate designs with the smooth, satiny finish and closely-held dimensions characteristic of "lost wax" castings. Casting tolerances start at plus or minus 0.005" although under certain circumstances closer tolerances can be held. This relatively new metal forming process solves many difficult problems in design, tooling and production of metal components.

fuel injectors from precision castings



Fuel injectors and carburetors for aircraft are mechanisms containing a variety of peculiarly shaped component parts. The usual procedure is to use hardenable, chrome stainless steels, Types 416 and 440F, which are most adaptable to easy machining. However, to save costs in machining from bars, stocks and forgings, Crucible applied Accumet Precision Castings. The close size control and good surface finish of the castings eliminate many costly machining operations — saving manpower, machine time and tooling expense.

more information available on castings

Long a leader in the development of precision investment castings, Crucible offers you the services of an alert metallurgical staff to help you profitably apply these specialty steels to your operation. Write us for more detailed information. CRUCIBLE STEEL COMPANY OF AMERICA, General Sales and Operating Offices, Oliver Building, P. O. Box 88, Pittsburgh 30, Pennsylvania.

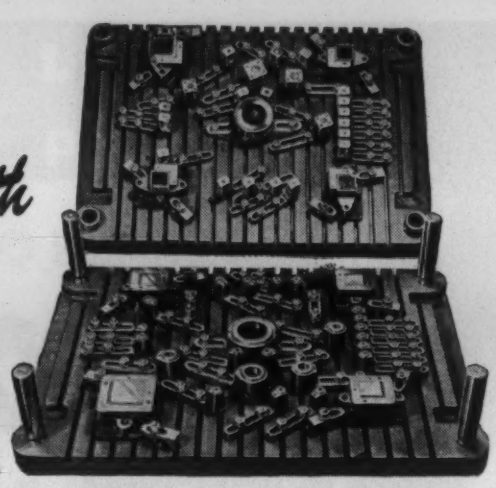
CRUCIBLE first name in special purpose steels

51 *years of* Fine *steelmaking*

PRECISION CASTINGS

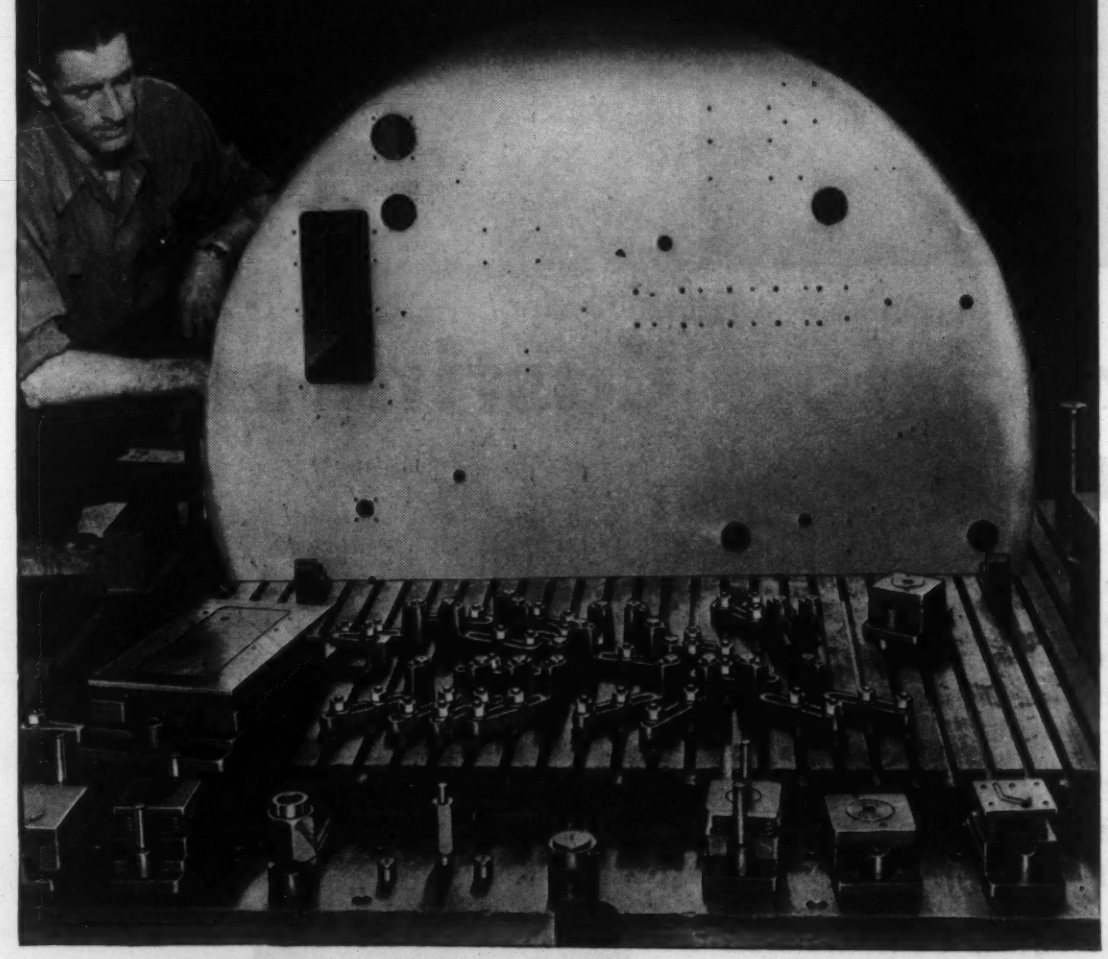
REX HIGH SPEED • TOOL • STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

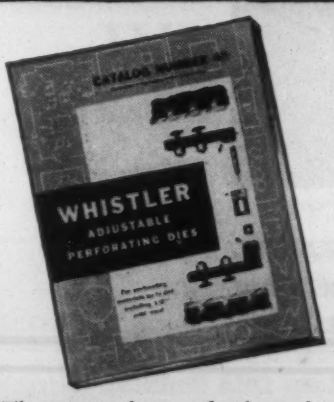
Get into Production in a few hours with



WHISTLER ADJUSTABLE DIES

Whistler Adjustable Perforating Dies are in use everywhere . . . working in both large and small presses.





There are plenty of other advantages in using Whistler Adjustable Dies. It makes sense to get the complete story. And it's easy to do. Write for your Whistler Catalog today.

Whistler perforating dies now offer a double-barreled advantage in getting into production faster. Standard sizes of round hole punches and dies... 1/32 to 3"... can be shipped promptly. Special shapes... squares, ovals, rectangles, group and notching dies, are quickly made to order.

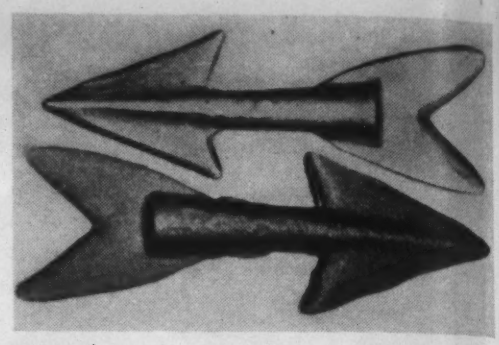
Equally important, set-ups are simple... take only a short time. Same units can be rearranged or units added in setting up different jobs. Production is thus speeded while die costs are amortized through continued re-use.

No special tools are needed. All parts are interchangeable. The heavy duty series of punches and dies easily pierce materials up to 1/4" mild steel.

S. B. WHISTLER & SONS, INC.

756 MILITARY ROAD • BUFFALO 17, NEW YORK

New Materials and Equipment



Shown here is a before and after print of a bronze casting deburred and finished with the new barrel finishing compound.

is said to yield beautifully uniform metallic colors and finishes in extremely short cycles.

Applicable for such uses as roughing, deburring and cleaning in a single operation, the compound can be used for finishing either with or without media, and with selected nonferrous media. Recommended quantities are only 4 oz of compound for finishing runs in a 32- by 30-in. tumbling barrel at high water level. As a cutting compound in deburring operations, only 1 to 2 oz of compound at low water level is needed.

Principal advantages claimed are economy, fine finish, uniform metallic colors, and greatly reduced time cycles on all operations.

Heavy-Duty Metal Primer Effective on Corroded Metal Surfaces

A metal primer that is said to work well with both active solvent protective coatings and conventional paints and to be completely effective on the severely corroded metal surfaces so commonly found in process plants has been developed by *Prufcoat Laboratories, Inc.*, Cambridge, Mass.

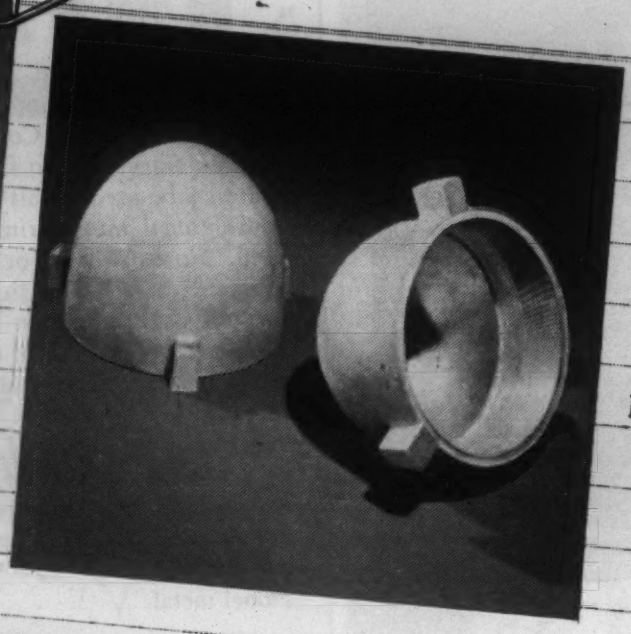
Designated Prufcoat Primer P-50, the primer has the application simplicity of, and serves the purpose of the commonly used zinc chromate and red lead types of primers. Unlike conventional types, however, the new product requires only overnight drying prior to the application of active-solvent finish coats.

According to the manufacturer, the outstanding features of the new primer are:

The primer vehicle is such that the pigments are completely free to perform their rust inhibitive function. Thus, under-film corrosion is effectively prevented.

Being a heavy bodied material, the primer deposits a relatively heavy film which tends to level out rough surfaces and

What's the *right* X-Ray film?



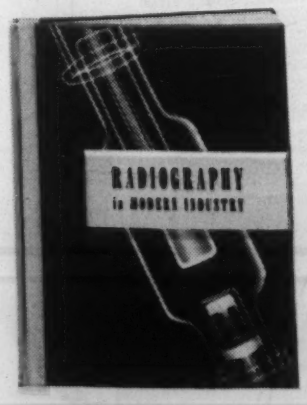
Product:
Drill press housing
Material:
Aluminum alloy—¼" thick
Equipment:
X-ray machine, 140 KV.

ANSWER:

KODAK INDUSTRIAL X-RAY FILM, TYPE A

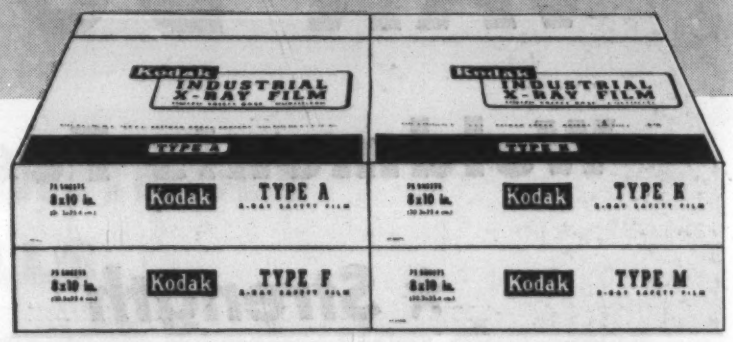
Hours of machining time were involved—so it was important that these housings be sound—that no irregularity should wait to be revealed by the cutting tools. In a matter of minutes, radiography checked for defects.

The radiographer chose Kodak Industrial X-ray Film, Type A, because this film has enough speed to keep exposures reasonably short even at low voltages. Its high contrast and fine graininess are also valuable in taking full advantage of higher kilovoltage machines in detecting irregularities in thick or dense materials.



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get your copy from your local x-ray dealer—price, $3.



A TYPE OF FILM FOR EVERY PROBLEM

To provide the recording medium best suited to any combination of radiographic factors, Kodak produces four types of industrial x-ray film. They also provide the means to check welds efficiently and thus extend the use of the welding process.

Type A—has high contrast with time-saving speed for study of light alloys at low voltage and for examining heavy parts at high kv. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity for direct exposure or with lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltage and for much million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays, exposed directly or with lead screens.

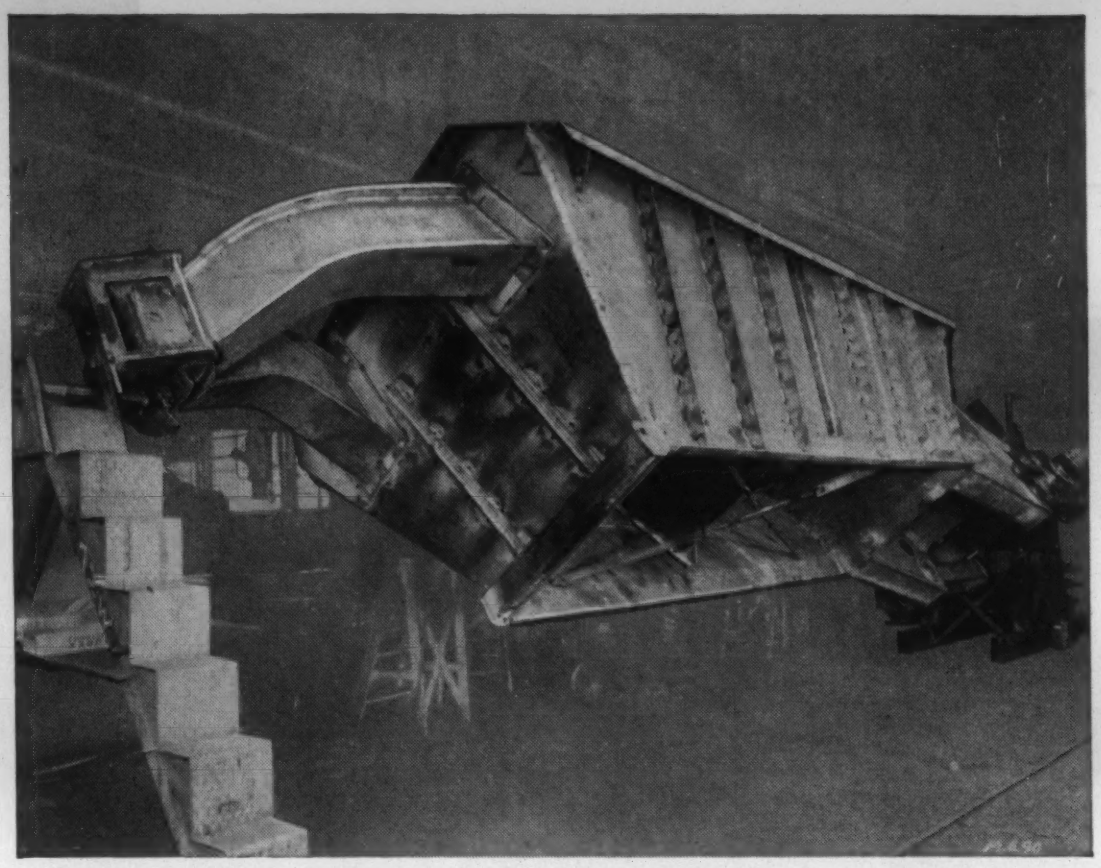
Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage without use of calcium tungstate screens.

EASTMAN KODAK COMPANY
X-ray Division · Rochester 4, N.Y.

Radiography...

another important function of photography

Kodak
TRADE-MARK



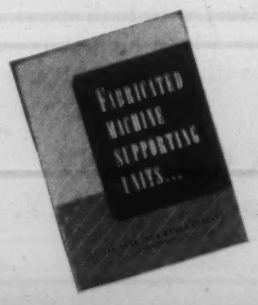
VAN DORN

Weldments Feature

★ Strength
★ Uniformity
★ Economy

Yes, Van Dorn Weldments are widely known for their outstanding quality—for they are backed by Van Dorn's complete fabricating facilities . . . experienced design engineers . . . specially trained workmen . . . 77 years' experience in metal working.

Consult us about your requirements—no obligation, of course. **The Van Dorn Iron Works Co., 2685 East 79th Street, Cleveland 4, Ohio.**



Send For

FREE WELDMENT BOOK

● *Profusely illustrated; describes the many advantages of weldments, and Van Dorn's extensive facilities.*

New Materials and Equipment

provides the needed extra protection at sharp edges, rivets, projections and other vulnerable points. Coverage on smooth metal averages 400 sq ft per gal.

It may be used for all applications where conventional metal primers are ordinarily used. No extra steps or special operations are needed. It is well suited for spot priming old work, or it can be used as a complete over-all prime coat on surfaces having old, not completely removed paints or coatings.

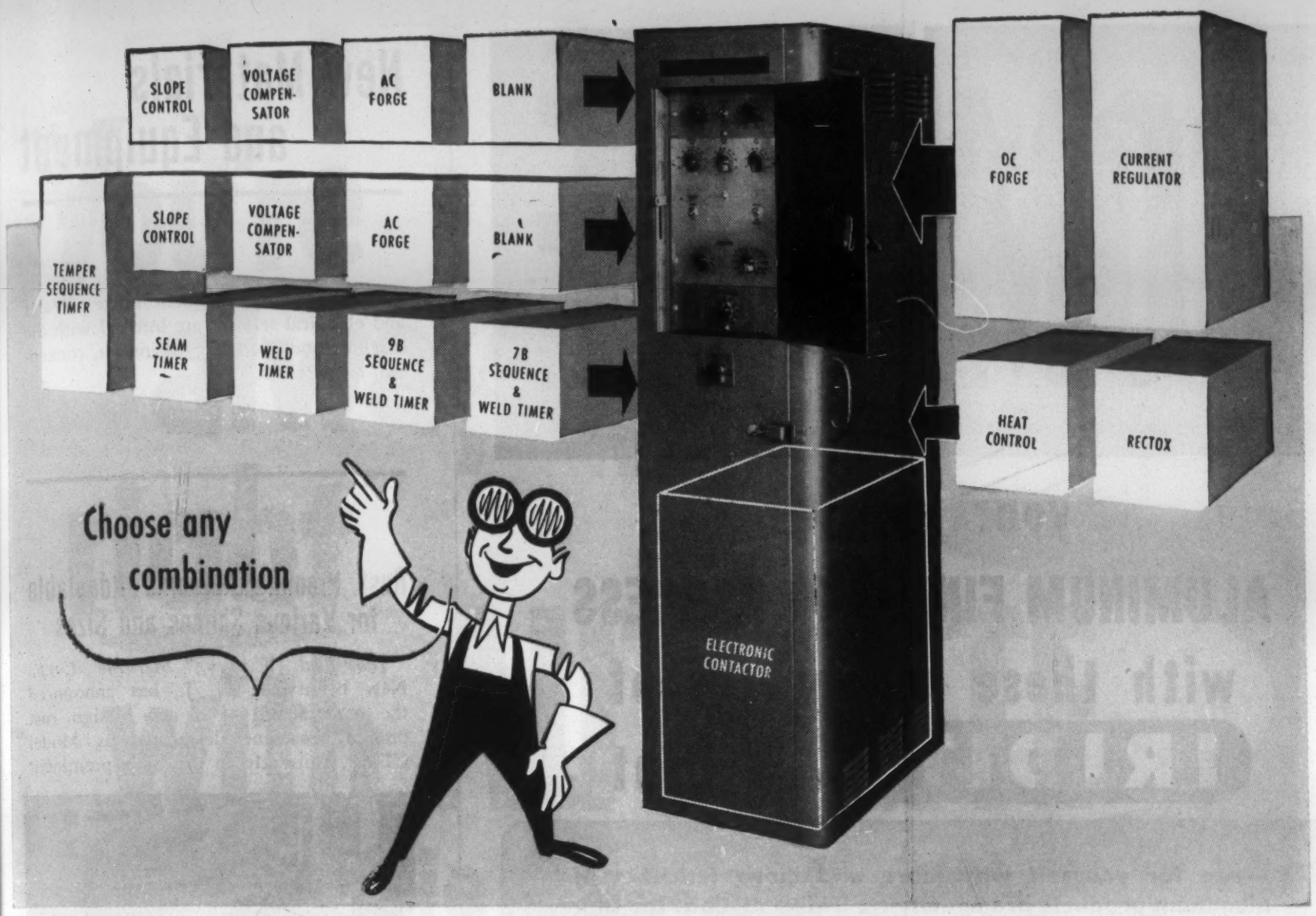
Prufcoat can be used on either ferrous or nonferrous metals. It is highly effective from an inhibitive standpoint on iron, steel, aluminum and magnesium. It also exhibits good adhesion to brass, copper, lead and monel metal.

Tumbling Machine Offers Increased Capacity

The *Grav-i-Flo Corp.*, Sturgis, Mich., has added a new model tumbling machine to its line of equipment. With two 18- by 40-in. I.D. compartments, the new Model 36-2 machine offers increased capacity per area of floor space over previous equipment, permitting the grinding, de-burring and finishing of metal parts in larger quantities in faster time cycles.

Other outstanding features of the new unit include: compartments are furnished with ½-in. plate unlined or ¼-in. plate rubber-lined; doors have cam locks with manually released safety stops to provide pressure relief; magnetic starter has a reduced voltage control to meet plant electrical standards; and the 220 to 440-v,

This new tumbling machine permits the grinding, de-burring and finishing of metal parts in larger quantities in faster time cycles.



KEEP YOUR WELDING CONTROLS OUT OF MOTH BALLS

Interchange these components to match production changes

Now you can keep your resistance welding control "on the line", regardless of production changes. With a Westinghouse Welding Control you merely add or substitute the necessary control components.

The Westinghouse Welding Control is built up of basic control components and auxiliary control units. Basic controls include the electronic contactor and sequence and weld timer, synchronous or nonsynchronous. Auxiliary controls include a wide range of functional units among which are: forge timer, slope control, voltage compensator and dual weld attachment. Combinations of the complete line of components can be assembled to meet the needs of practically all resistance welding techniques. All component units plug in to either a 600 or 1200-frame electronic contactor structure.

Each unit is self-contained and completely prewired at the factory. Mount the panel and insert the polarized plug—that's all it takes to make a complete change-over.

Many other advancements in control design such as the transformer-type flow switch, are built into this packaged control for resistance welding. Get the complete story from your Westinghouse representative or write for Booklet B-4309. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-27006

YOU CAN BE SURE.. IF IT'S Westinghouse

RESISTANCE WELDING CONTROL

COMPARE

your present

ALUMINUM FINISHING PROCESS

with these advantages of

IRIDITE® Al-Coat

—see for yourself why more and more finishers of aluminum products are specifying Iridite Al-Coat for any wrought, cast or buffed aluminum part.

1. IN PROCESSING

Faster—Just one simple dip, 10 seconds or only two minutes, depending upon your finishing specifications. No sealing dip, no special drying.

Simpler—Non-electrolytic, no heating or exhaust units, operates at room temperature. No special precleaning baths required.

2. IN APPEARANCE

Clear—Protects metal without changing its original appearance.

Colored—Heavier, iridescent yellow film provides greater protection.

3. IN PERFORMANCE

Corrosion Resistance—Up to 1,000 hours salt spray on wrought stock, 250 hours on castings. Approved under government specifications.

Abrasion Resistance—Will not flake or peel from buffing, bending or scraping.

Paint Base—Blocks underfilm corrosion; grips paint, holds it firmly.

Welding—Finished surface can be spot welded, coating actually aids shielded arc welding.

Conductivity—Offers low surface resistance to electrical current.

4. IN COST

Comparative figures show that Iridite Al-Coat saves as much as 50% over other aluminum finishing processes. *Let us prove this to you.*

Write today for FREE SAMPLES of Iridite Al-Coat. Or, send samples of your product for test processing.

Iridite is approved under government specifications.

ALLIED RESEARCH PRODUCTS
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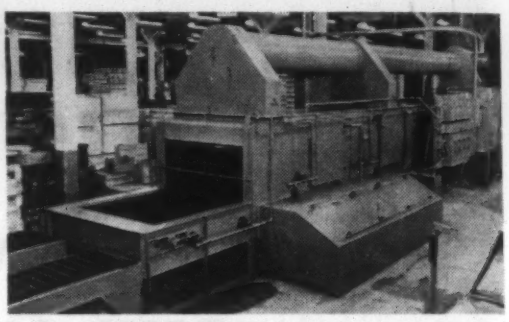
REPRESENTATIVES IN PRINCIPAL INDUSTRIAL CITIES; West Coast: L. H. BUTCHER COMPANY
Manufacturers of Iridite Finishes
for Corrosion Resistance and Paint Systems for Non-Ferrous Metals; ARP Plating Chemicals

New Materials and Equipment

5-hp motor has a magnetic brake. Water and electrical services are integral with the machine and available for instant, convenient connections.

Rust Proofing Machine Adaptable for Various Shapes and Sizes

Industrial Washing Machine Corp., New Brunswick, N. J., has announced the manufacture of a new design rust proofing machine designated as Model CT-RP. Currently in use at a prominent



This rust proofing machine features an unusually high capacity of 500 sq ft of conveyor space per hr.

government installation, this machine features an unusually high capacity of 500 sq ft of conveyor space per hr.

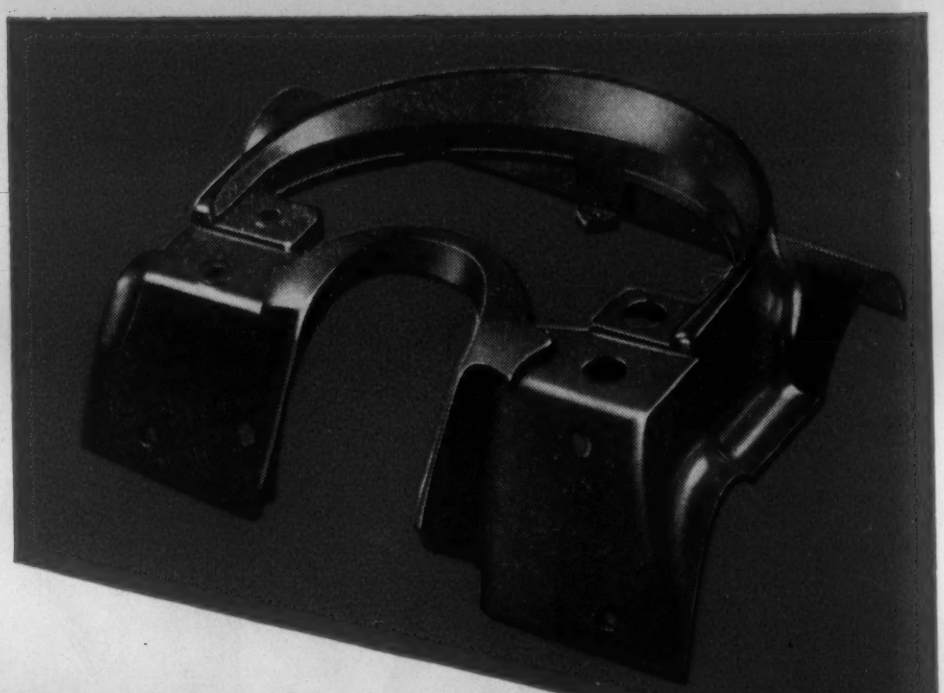
In operation, the unit first sprays work with a rust preventative, the built-in, explosive-proof infra red oven quickly dries it, and then the work is cooled to permit immediate handling. Additional safety features include an automatic carbon dioxide system and fully electrical operating controls. The continuous conveyor is kept free, clear and clean of residue by a special rotating brush and a detergent spray. This self-cleaning feature is said to eliminate the need to stop the machine and interrupt production to clean the conveyor.

Welding Electrode Saves Copper

A new type of resistance welding electrode, marketed under the name of Kaptrode, has been announced by *Weiger Weed & Co.*, 11644 Cloverdale Ave., Detroit 4, a division of *Fansteel Metallurgical Corp.*

The electrode consists of an expendable cap that fits into a semi-permanent adapter

You're always right with AUTO-LITE Die Castings



● Many of America's leading manufacturers, producing a wide variety of products, are benefiting from Auto-Lite die cast research, experience and advancement. Such developments as high pressure casting, special alloying practices and improved quality through the "controlled metals process" make Auto-Lite the logical source of supply for precision die castings. Address inquiries to:

THE ELECTRIC AUTO-LITE COMPANY
Die Casting Division
Woodstock, Illinois
Lockland Division, Cincinnati 15, Ohio

600 So. Michigan Ave. Chicago 5, Illinois
723 New Center Bldg. Detroit 2, Michigan

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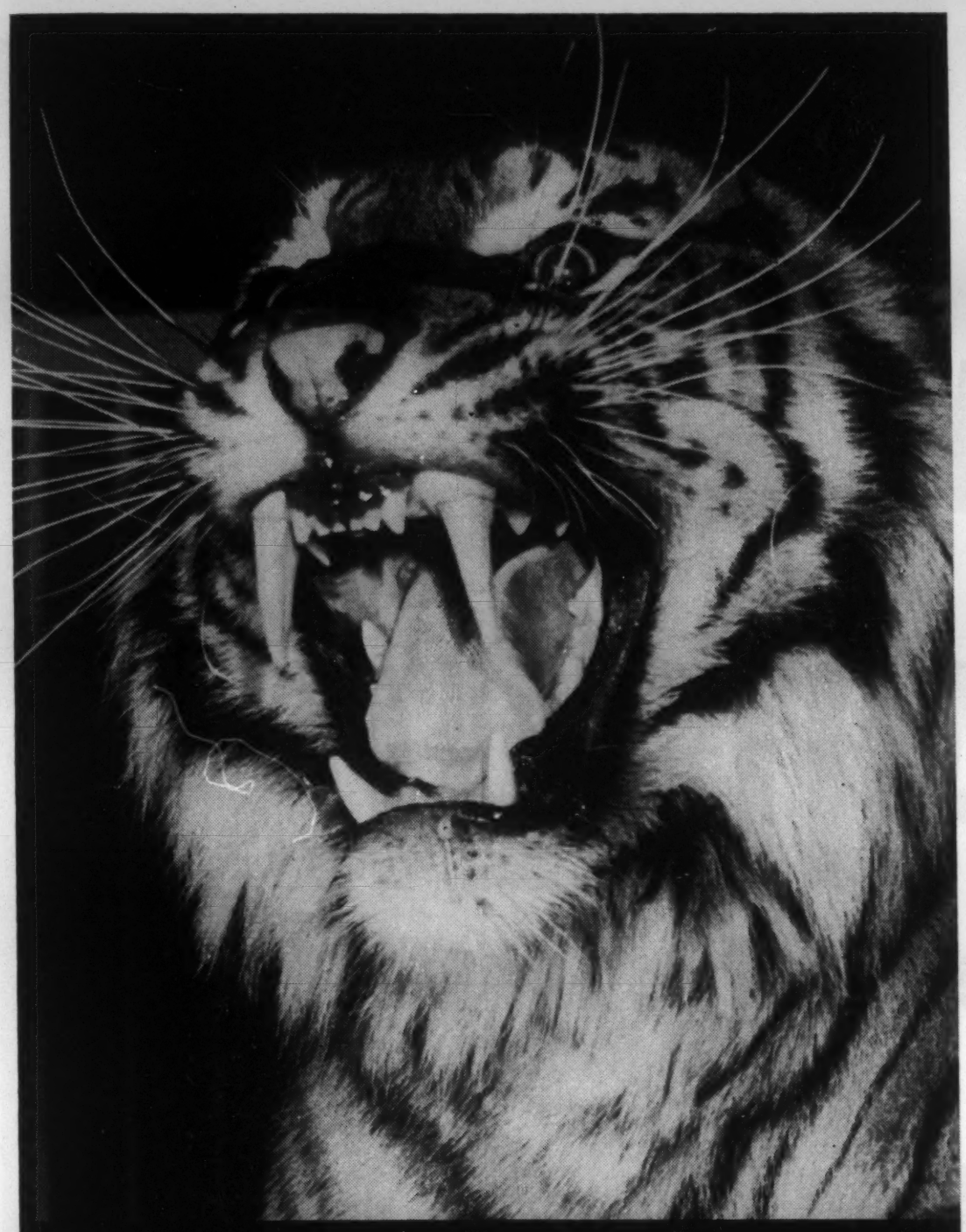

Let us try to help you . . . Sometimes we can relieve the pressure of customer's demands by suggesting alternate material or production changes which will help you get more use from the steel you use. Whatever your steel problem may be, why not put it up to United States Steel Supply?

UNITED STATES STEEL SUPPLY COMPANY

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USS

UNITED STATES STEEL

New Materials and Equipment

This replaceable resistance welding electrode fits into semi-permanent adapter shank with savings in copper, in electrode costs and in inventory.

shank which, in turn, fits into any standard Morse taper type electrode holder. Depending upon the length of the adapter shank, copper savings up to 75% are possible.

Fitted into the adapter shank by means of a blow of a rubber or rawhide mallet, or by pressure of the welding machine, electrodes are removed with the Kaptrode extractor, a tool easily adapted from the familiar toggle pliers.

The new electrodes are made in six nose styles (pointed, dome, flat, offset, truncated cone and radius face), in three RWMA alloys (Class 1, 2 and 3), and 2 Morse taper sizes (No. 1 and 2).

New Electrodes and Hardening Compounds Have Variety of Uses

Eutectic Welding Alloys Corp., 40-40 172 St., Flushing, N. Y., has announced several new electrodes for various applications. For all-around use where a relatively inexpensive hard overlay electrode is required and when the higher priced high alloy overlays do not seem warranted, the company has released EuteChrom 2X for a.c.-d.c. welding. A flux-coated alloy that deposits strong, dense overlays with good corrosion resistance at lower amperages, the new hard overlay electrode is recommended for use with carbon and alloy steel surfaces that are subjected to severe abrasive wear and comparatively mild impact. It is available in 1/8-, 5/32-, 1/4- and 3/16-in. dia.

A new electrode for cast iron welding, EutecTrode 26" has also been announced by the company. This new electrode, it is said, differs from conventional ferrous electrodes in that, for the first time, the carbon content in the deposited metal is evenly distributed. The analysis of the metal deposited by the electrode will show a uniform amount of carbon so that the de-

Licking Corrosion a New Way

Easy way to defeat corrosion is to use an alloy that won't corrode . . . . .

If you can get it.

If you can't, and many can't these days, Ferro has a proved answer.

Ferro's engineering-plus-chemistry team has a high-temperature-resistant Porcelain Enamel that stands up to 2,100 degrees.

Key words there are STANDS UP, which means no cracking, no scaling . . . in other words, this finish keeps on resisting gases, acids and temperature.

Beside that, it is easily and quickly applied, it is light, it has high heat emissivity.

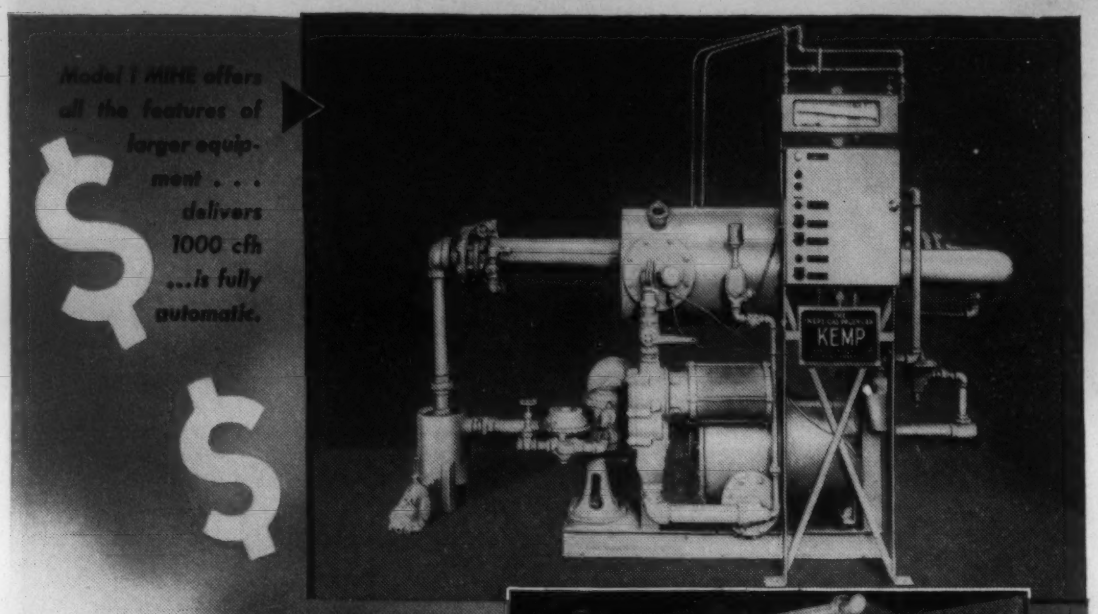
This is another area where Ferro has successfully teamed a unique store of engineering know-how with specialized chemical experience to achieve a product and a service timed to today's needs of industry.

Perhaps Ferro can bring an answer to you in this sector of our Frontier.

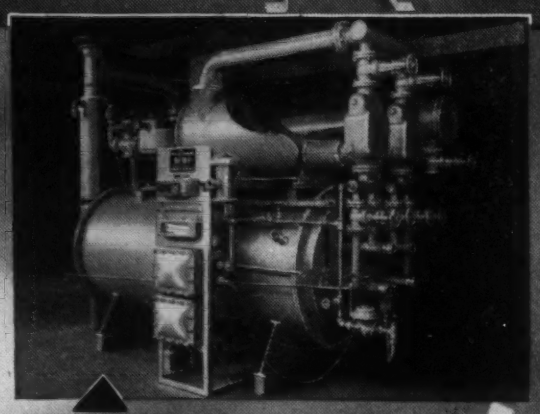
FERRO CORPORATION • CLEVELAND 5 • OHIO

FERRO

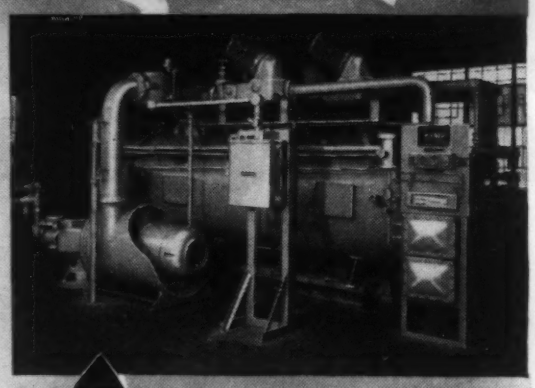
OUR FRONTIER IS ENGINEERING
TEAMED WITH CHEMISTRY....



Model 1 MIHE offers all the features of larger equipment . . . delivers 1000 cfh ...is fully automatic.



Model 6 MIHE is ideal for agitating, bubbling and blanketing in synthetic resin plants . . . delivers 6000 cfh.



Model 60 MIHE produces 60,000 cfh . . . is widely used for purging and blanketing in the petroleum industry.

It pays to GENERATE your own INERTS

Kemp Inert Gas Generators Save $9 of the $10 you now spend for Inerts

Need inerts for purging, fire protection, mixing, blanketing or a special application? You can save up to 90% on Inert Gas costs when you generate your own inerts with a Kemp Inert Gas Producer. The cost of transportation, bottle juggling, storage, deposits on cylinder inventories and the initial higher cost of bottled nitrogen or CO_2 is eliminated.

ABSOLUTELY DEPENDABLE

No matter what the demand, Kemp Inert Gas Generators give you the same analysis Inert Gas from 20% to 100% of capacity. The Kemp Industrial Carburetor, part of each installation, burns ordinary gas just as it comes from the mains. Assures complete combustion without "tinkering." Produces a clean, chemically inert gas to meet your most exacting requirements.

SEND FOR DATA

Whatever your requirements, always specify Kemp. *To find out how you can benefit:* Tell us your atmosphere gas problem, and we'll show you how Kemp can solve it and save you money!

KEMP OF BALTIMORE

INERT GAS GENERATORS

Write for Bulletin I-10 for technical information C. M. KEMP MFG. CO. 405 E. Oliver St., Baltimore 2, Md.

CARBURETORS • BURNERS • FIRE CHECKS • ATMOSPHERE & INERT GAS GENERATORS
ADSORPTIVE DRYERS • METAL MELTING UNITS • SINTERING EQUIPMENT • SPECIAL EQUIPMENT

New Materials and Equipment

posited material is similar to a high tensile, high carbon steel, thereby increasing the tensile strength of the weld.

Two new, moderately priced compounds for emergency surface hardening of small tools or parts with an ordinary torch have also been introduced by Eutectic. Instant Hardener #1 is said to harden steel tools, parts, edge threads, dies, drills, etc., without the fuss and mess of conventional heat treating. Instant Hardener #2, while applied in a similar manner as #1, is strengthened with small hard facing particles mixed right into the compound. These, when heated, fuse with the parent metal to give a combination of hardening and hard overlay, making it particularly effective for such applications as hardening a plate against abrasive wear.

New Finish for Glass Fiber Plastic Laminates and Moldings

Garan Chemical Corp., 7213 Santa Monica Blvd., Los Angeles 46, has announced a new finish developed to overcome the loss in mechanical strength of glass fiber reinforced polyester laminates and moldings caused by exposure to moisture.

The increase in wet strength retention of the new finish permits the utilization of a greater percentage of the strength inherent in the glass fiber as a reinforcement. Not only are stronger parts produced, but also new applications can now be considered which heretofore have been impractical. In addition, the improved water resistance and decreased water absorption of such reinforced structures should be of interest where electrical properties are important.

In general, polyester laminates made with glass fabric containing the Garan finish show a loss in mechanical strength of 10% or less after prolonged immersion in water or exposure to high humidity. The water absorption, after 24 hr, is less than 0.10%, and after 100 days immersion in water is less than 0.5%.

Molded Iron Powdered Toroidal Cores

Molded powdered-iron toroids are now being produced by *Lenkurt Electric Co.*, 1185 County Rd., San Carlos, Calif., in a

we've built a GIANT

...to produce high vacuum in bigger chambers—at less cost—than ever before

SAY you're producing one of the modern metals that has wonderful properties but can't stand oxygen at high temperatures. Or maybe your problem is a large wind tunnel, a synchro-cyclotron, or a vacuum dehydration chamber for biologicals.

You want to push out into the atmosphere as much air or gas as possible at the lowest cost. You may need to exhaust down to 1/2000th of atmospheric pressure or as low as 1/75,000th of an atmosphere.

DPi now supplies a series of non-mechanical pumps which can operate in this pressure range at rates well over 10,000 cubic feet per minute, compressing air and gas to the point where mechanical pumping becomes highly efficient—to pressures as high as 10 mm Hg where needed.

If you will tell us your vacuum pumping requirements, we'll be glad to show you how these unique oil ejector pumps make possible a new order of operating economy for large high vacuum systems. Write *Distillation Products Industries,* Vacuum Equipment Department, 733 Ridge Road West, Rochester 3, N.Y. (Division of Eastman Kodak Company).

DPi

high vacuum research and engineering

Also... vitamins A and E... distilled monoglycerides... more than 3400 Eastman Organic Chemicals for science and industry

An Important Material for Designers

GLASS

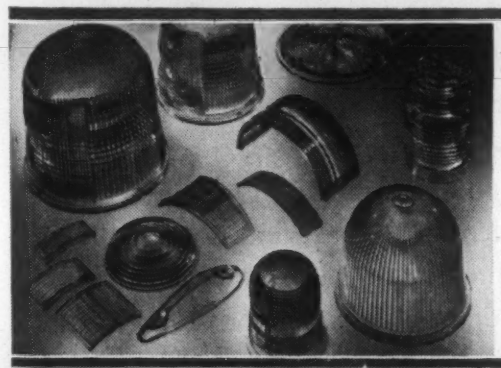
offers many advantages . . .

KOPP

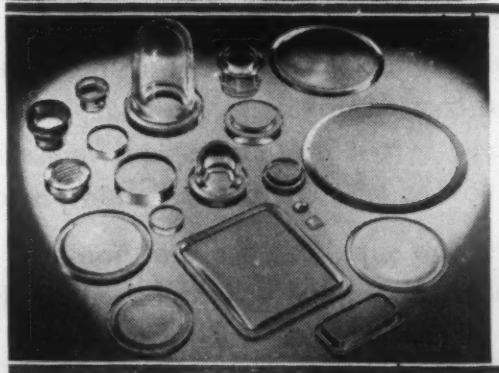
helps you use it PROPERLY

Kopp engineers will help you make full use of the beauty and durability of glass to improve the sales appeal and performance of your products.

Glass is colorful, beautiful, strong, wear-resistant; it won't rot, rust, warp or stain; it is sanitary and easily cleaned. We will be glad to help you employ these advantages in your products.



Skillful design and careful workmanship are needed to produce the precision-made, intricate lenses shown here. These are representative of Kopp production.



Sight glasses are used to permit one to see inside a closed container or other vessel. Such items form an important part of Kopp production.

Color, accurate shape and size and dependable uniformity are properties demanded of Indicator glasses. Kopp makes many types and sizes—from tiny indicator buttons to panels with integral lenses and prisms.

KOPP GLASS

KOPP GLASS, Inc.

SWISSVALE, PA.

New Materials and Equipment

These toroidal cores are available in a size range from 0.800- to 3.375-in. outside diameters.

size range extending from 0.800- to 3.375-in. outside diameters. Included is the wedding ring, the smaller size illustrated.

These cores are available in magnetic materials which can be chosen to accentuate high-Q, high inductance, low generation of harmonic distortion products, high magnetic and temperature stability, or small size and low cost. The cores are also supplied wound to individual specifications, cased, uncased, or hermetically sealed.

Fluorescence Analysis Unit Incorporates Many Design Improvements

A new Norelco fluorescence analysis unit which is said to offer many design improvements to facilitate rapid qualitative and quantitative analysis of constituents in metals, alloys, minerals, ores, chemical mixtures and compounds, is now in production at *Research & Control Instruments Div., North American Philips Co., Inc.*, 750 S. Fulton Ave., Mt. Vernon, N. Y.

Specimens under analysis are exposed to an intense beam of exciting x-radiation. This results in individual x-radiations being generated by elements susceptible to such excitation. The combined radiations representing the various constituents are passed through a special collimating system to a crystal which serves as an analyzer and which, by proper positioning, reflects each of the individual radiations at a specific angle. Intensities are measured by means of a Geiger counter, arranged together with a crystal and its angulating mechanism on a specially designed goniometer. Data obtained from this system can be evaluated in terms of percentages of the elements present.

The unit employs a wide range vertical goniometer with a sweep radius of 170 mm instead of the horizontal assembly used on the original model and a horizontal, water-cooled oil-insulated x-ray tube operated from a standard water-cooled Norelco diffraction unit. The output of the special volume-sensitive Geiger

ELECTRUNITE TUBING *Eases Life-*

FOR THE MANUFACTURER...

FOR THE PATIENT...

HOSPITAL PATIENTS can relax in every position, from full-reclining to upright, in this sturdy rejuvenating chair made by Barcalo Manufacturing Company. Steel tubing provides the stiffness and rigidity to make the chair steady and reassuring to the patient, yet light to move.

The manufacturer likes the way ELECTRUNITE Steel Tubing works on this application. Uniform ductility and wall thickness assure rapid, predictable forming and bending of the tubes to shape. Where tube ends must be fully flattened at joints, there's no trouble with cracks and fractures. The excellent surface of this ELECTRUNITE Tubing requires no special handling or trick treatments to hold long-lasting finishes under severe service.

Have you considered using ELECTRUNITE Steel Tubing in your essential products, such as these invalid chairs? We'll be glad to discuss your problems . . . and offer you the benefits of Republic's 3-Dimension Metallurgical Service. It's the helpful service that focuses the knowledge and experience of field, mill, and laboratory metallurgists on your fabrication problems.

REPUBLIC STEEL CORPORATION
STEEL & TUBES DIVISION
224 EAST 131st STREET
CLEVELAND 8, OHIO

Republic
REPUBLIC STEEL ®
ELECTRUNITE® TUBING

Alumibond*

for

molecular bonding of

ALUMINUM

and its alloys to

IRON and STEEL

and their alloys provides

1. LIGHTWEIGHT combining the lightness of aluminum and the strength of steel or iron and taking advantage of the machinability of aluminum.

2. HEAT DISSIPATION.

3. BEARING PROPERTIES.

4. CORROSION RESISTANCE.

APPLICATIONS

Bearings • Heat Exchangers • Large Diesel Pistons • Corrosion Resistance • Rotors Radio-Anode Tubes • Brake Drums • Cooling Cylinder Fins • Housings • Gears • Bi-Metallic Assemblies • Oil Refinery Parts • Textile Machinery • Bag Making Machinery • Heat Dissipation Units

WRITE TODAY FOR ALUMIBOND BOOKLET

ARTHUR TICKLE

ENGINEERING WORKS

25 Delevan Street, Brooklyn 31, N. Y.

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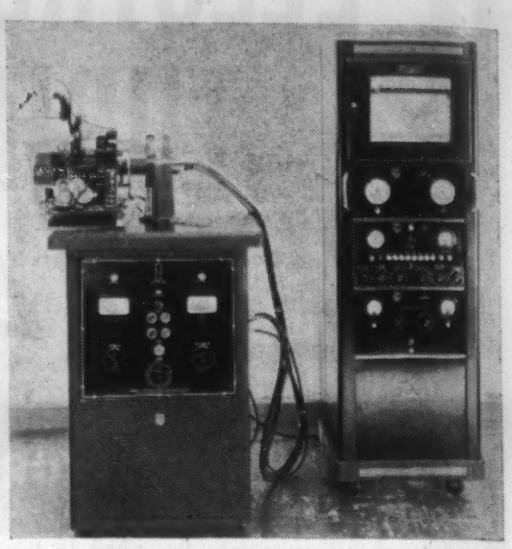
New Materials and Equipment



This fluorescence analysis unit operates at potentials up to 50 Kv peak and at current values up to 50 Ma.

counter is processed in electronic circuits for the purpose of driving a strip chart recorder or a count register.

As distinguished from x-ray diffraction, which gives precise data about atomic structure, fluorescence analysis provides precise quantitative and qualitative data with respect to the elements present. Difficult analyses involving solids, semi-solids and liquids can be carried out in much less time than when ordinary chemical methods are employed, and the method is said to be entirely nondestructive and permit the analysis of very small specimens.

Acrylic Thickeners Possess Unique Properties

Currently being offered by *American Polymer Corp.*, Peabody, Mass., Polyco 296BT and 296N acrylic thickeners are aqueous solutions of sodium polyacrylate. They are water-soluble anodic colloids furnished as straw-colored, homogeneous solutions containing 15% solids. Polyco 296BT is a high-viscosity grade and 296N is a medium viscosity grade.

These acrylic thickeners are recommended primarily as stabilizers, protective colloids and thickeners for natural, synthetic rubber and resin lattices. They are claimed to possess unique adhesive, suspending, emulsifying and film-forming characteristics which suggest many other industrial uses.

Outstanding properties claimed for these water-soluble resins are: high viscosities at low temperatures; flexible, tough, elas-

HOW ENGINEERS USE GLASS TO *prevent* SERIOUS FIRES

To get fires under control faster, regardless of variations in operating requirements, Grinnell engineers developed a positive, fast-opening sprinkler head. Here's how a specially designed glass by Corning helped solve their problem.

In the Grinnell Sprinkler Head shown above, heat causes the liquid in the "Quartzoid"* bulb to expand, breaking the bulb, opening the head . . . and sending the sprinkler system into action much faster than is possible with solder type heads. The bulb is made to shatter at temperatures as low as 135° F. The temperature at which the sprinkler system goes into action depends on the amount of liquid in the bulb and the strict specifications to which Corning produces this glass.

Air lines and defects are eliminated to maintain uniform strength. Wall thickness is drawn to the closest tolerances to assure uniform breakage. Glass also eliminates corrosion, another factor which might interfere with operation.

Glass has many other industrial uses. Are you developing a new product, or faced with a material shortage? You'll find that Corning has the experience, the technical skills and manufacturing facilities to produce glass that may do a better job than existing materials.

*Reg. T.M. of Grinnell Co., Inc.

PYREX TM REG US PAT OFF

CORNING GLASS WORKS

CORNING, NEW YORK

Corning means research in Glass

1851 • 100 YEARS OF MAKING GLASS BETTER AND MORE USEFUL • 1951

Technical Products Division: Laboratory Glassware, Signalware, Glass Pipe, Gauge Glasses, Lightingware, Optical Glass, Glass Components

GLASS IS AVAILABLE NOW—ECONOMICAL, TOO

CORNING GLASS WORKS, Dept. MM-12, Corning, N. Y.

Please send me your "Designers Bulletin IZ-1."

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

In tanks, guns, bombs, shells and missiles; ships, planes, trucks, jeeps; radio, sonar, radar . . . almost everything you can mention in the realm of war materiel—more and more of the component parts are being made of metal powders. This modern material has become increasingly important to the quality, the faster output or the lower cost of production of these products.

Plastic Metals has been a leading producer of metal powders for 17 years—and is at present supplying metal powders for many of these Ordnance items. Iron, nickel, manganese, silicon and magnetic iron oxide powders—and combinations of metal powders to meet exacting requirements are being produced daily by Plastic Metals.

If you are manufacturing any parts for military materiel—or for any civilian product where shortage of metals is causing a serious problem—we shall be glad to put you in touch with qualified Metal Powder Fabricators with whom it may pay you to discuss the possibilities and advantages of metal powder parts to meet your specific needs.

PLASTIC METALS

DIVISION OF THE NATIONAL RADIATOR COMPANY
JOHNSTOWN, PENNSYLVANIA

New Materials and Equipment

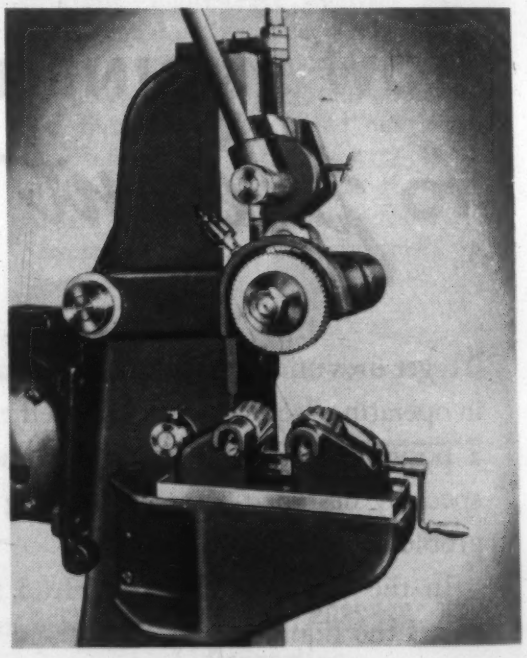
tic film-former; fully saturated, will not yellow, embrittle or oxidize; stable at alkaline and mildly acid pHs; derived from synthetic materials, will not rot, mildew or sour.

Suggested fields of application include: water-based latex paints; adhesives; pigment and clay binders; protective colloids; textile printing pastes; film formers; thickening agents; latex dipping; suspending agents; oil well additives.

De-Scaler and Cleaning Attachment

A new pipe and tube de-scaling and cleaning attachment for Steen Cut-Off machines has been announced by *Continental Machine Co.*, 1952 Maud Ave., Chicago 14.

The unit cleans rust, scale, paint and other deposits from pipes, posts and building columns, and it is particularly adapted for reclaiming used pipes and tubes.



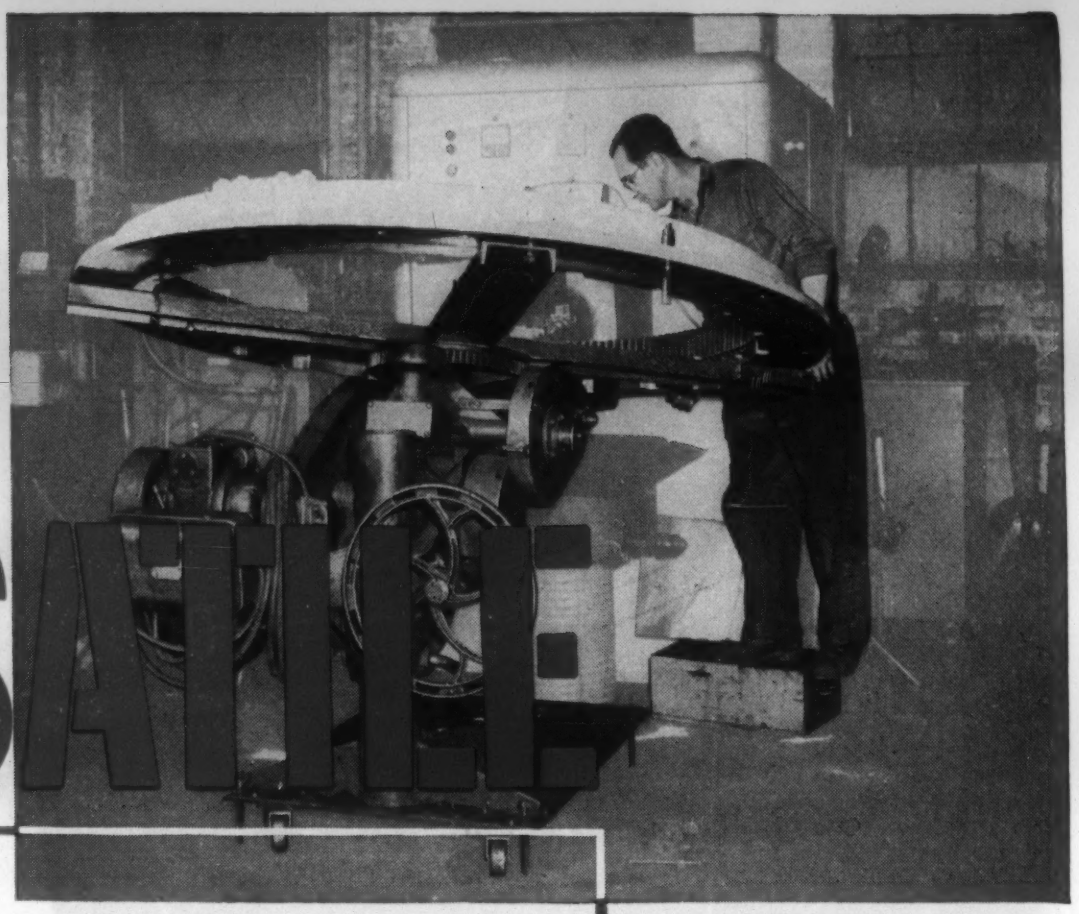
This cleaning and de-scaling attachment is especially adapted for reclaiming used pipes and tubes.

Most work requires only one pass through the rollers to completely remove all deposits. Sizes are available for cleaning pipes up to 12 in. in dia.

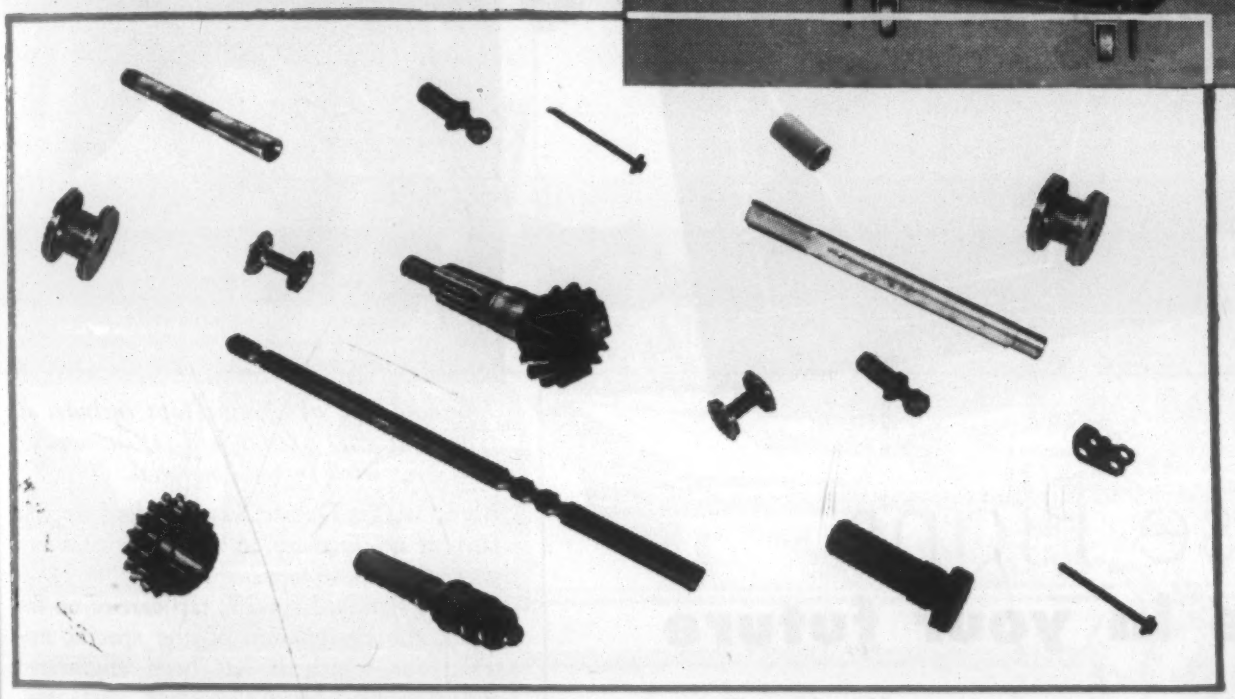
Specific Taps for Specific Materials

"Specific" taps—each produced for a specific material—are currently being offered by *Detroit Tap & Tool Co.*, 415

VERSATILE



"Internal ring gear being hardened on the Lindberg LI-25 Induction Heating Unit".



Investigate the amazing versatility of the Lindberg Induction Heating Unit—approximately 2000 different parts have been selectively hardened or annealed on this typical commercial heat treating installation.

FROM THE LARGEST—The internal ring gear illustrated above—with a 60″ inside diameter, 3½″ face with 187 teeth each individually heated and oil spray quenched.

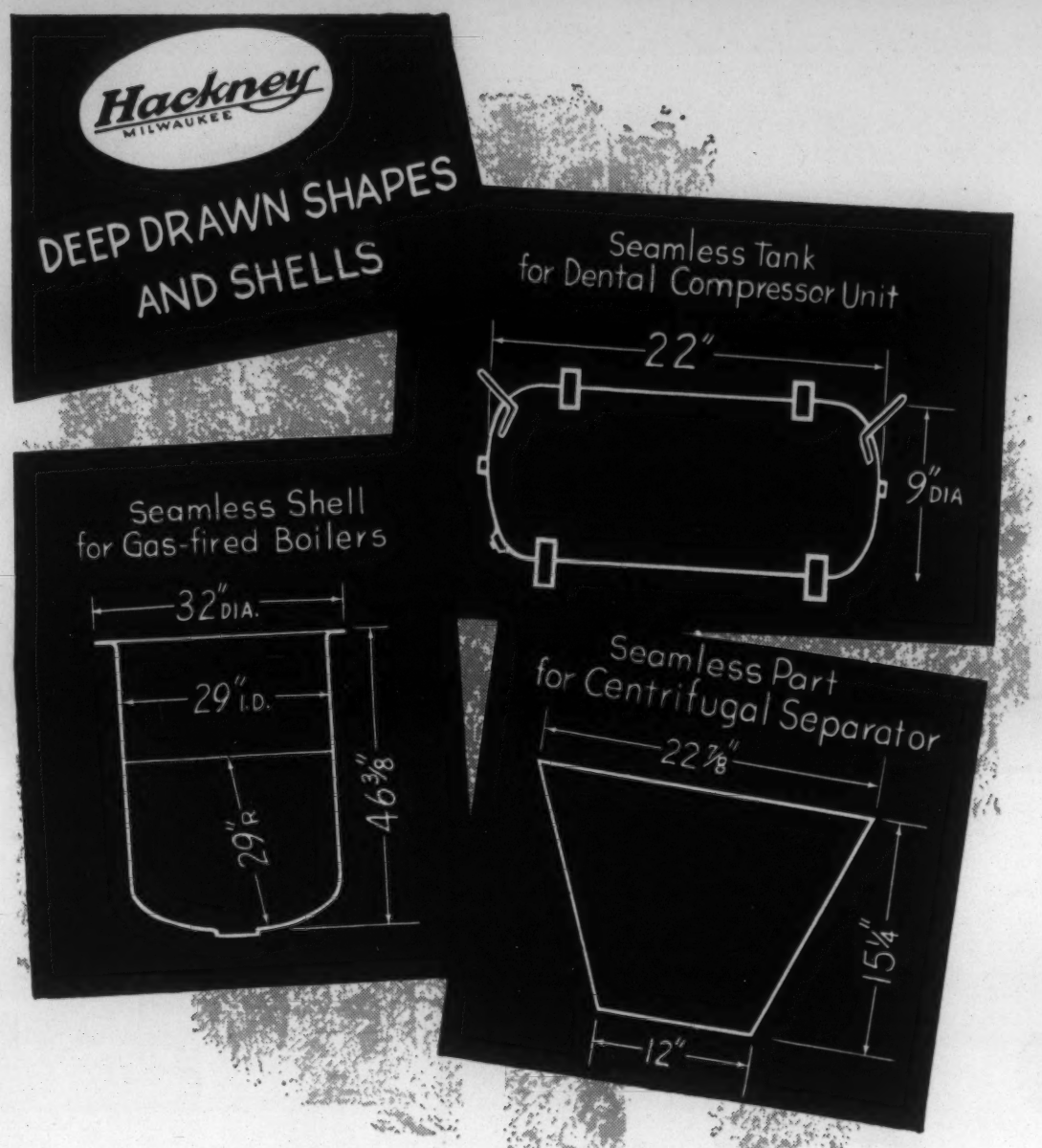
TO THE SMALLEST—This small 2″ stamped metal rocker arm was selectively heated and water quenched on the small square face at the rate of 3000 per hour. Investigate this versatile Lindberg Induction Heating Unit—it may supply the answer to your selective heating operations.

SPECIFY LINDBERG

for any heat treating or melting need! Lindberg manufactures every type and many sizes of melting and heat treating furnaces from tiny laboratory units to mammoth field erected installations—whether it's gas, oil, electric, arc, low or high frequency—consult your local Lindberg Office!

LINDBERG
HIGH FREQUENCY DIVISION

LINDBERG ENGINEERING COMPANY 2451 W. Hubbard Street, Chicago 12, Illinois



These Plans

may figure in your future

You and your product may share a better future when a Hackney Deep Drawn Part replaces a casting or forging in your product.

The Hackney Deep Drawing Process assures stronger shapes and shells because they're shaped under pressure from one piece of sheet metal . . . lighter weight parts because cold drawn metal does the work of heavy forgings and castings . . . and they're faster to produce because time-consuming machining and welding operations are eliminated.

Pressed Steel Tank Company, manufacturer of Hackney Products, has almost 50 years of specialized experience in deep drawing shapes and shells for many manufacturers in many industries. These Hackney Products are made in a wide variety of metals and alloys . . . in a capacity range from 1 quart to 110 gallons . . . inside diameters from approximately 3 inches to 32 inches.

See if Hackney engineers can help you adapt special shapes to improve existing products or to develop new products. Send us a drawing of your requirements today.

Hackney MILWAUKEE

PRESSED STEEL TANK COMPANY

Manufacturer of Hackney Products

1442 South 66th St., Milwaukee 14

1319 Vanderbilt Concourse Bldg., New York 17 • 241 Hanna Bldg., Cleveland 15

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CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

New Materials and Equipment

The new line of specific taps includes all types and sizes of standard taps commonly used in each material.

Blvd. Bldg., Detroit, as standard specific taps at no increase in cost over standard general purpose taps.

Each standard specific tap carries on the shank the designation of the specific material for which it has been engineered and produced, such as steel, cast iron, aluminum, brass, zinc or plastic. Those designated for steel are intended for most steels and tough materials. Cast iron taps are designed for the harder grades of cast iron commonly used today. Those stamped aluminum are for magnesium and other light metal alloys, while taps for zinc are to be used primarily for tapping of die castings.

Among the factors varied in the taps to make them specifically suited for specific materials are flute forms, chamfers and method of heat treatment of the exclusive M-11 chromium-cobalt high-speed steel used in taps produced by the company.

New-Type Flat, Sheathed Electric Heating Element

Syntron Co., 255 Lexington Ave., Homer City, Pa., has announced the manufacture of a new, flat, sheathed electric heating ele-

QUALITY
YOUNGSTOWN
SERVICE

SCRAPPY SAYS:
AID DEFENSE
MORE SCRAP
TODAY...
MORE STEEL
TOMORROW

THE iron and steel industry faces a serious scrap shortage, growing more critical every day. . . . It will be impossible for producers to make the steel tonnages demanded for rearmament and essential civilian needs, unless consumers cooperate by furnishing *more scrap*. . . Most desperately needed now is heavy industrial iron and steel scrap. . . . Keep the cobwebs from gathering at your own plant by turning in more of your own scrap today.

The Youngstown Sheet and Tube Company

General Offices -- Youngstown 1, Ohio
Export Offices -- 500 Fifth Avenue, New York
MANUFACTURERS OF CARBON ALLOY AND YOLOY STEELS

The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.

"HERE IS 4,500 cubic feet of gases FOR METAL TREATING!"

Barrett*

Standard Anhydrous Ammonia

When dissociated, one 100-pound cylinder of Barrett Standard Anhydrous Ammonia (Refrigeration Grade) yields 4,500 cubic feet of mixed gases—approximately 3,400 cubic feet of pure hydrogen and 1,100 cubic feet of pure nitrogen.

You effect real economies when you use Barrett Standard Anhydrous Ammonia as a replacement for other more expensive sources of hydrogen and nitrogen.

Engineers have obtained many advantages from the use of dissociated ammonia as controlled atmosphere in furnaces for bright annealing, clean hardening, copper brazing, sintering, reduction of metallic oxides, atomic hydrogen welding, radio tube sealing and other metal treating practices. Anhydrous ammonia also has unsurpassed qualities in the nitriding of steel, used as ammonia gas or dissociated.

The advice and help of Barrett technical men are available to Barrett customers without charge.

Barrett* Standard Anhydrous Ammonia

In 150, 100 and 50-pound cylinders for fast delivery from a stock point located near you. And in tank car shipments from Hopewell, Va., and South Point, Ohio.

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 RECTOR STREET, NEW YORK 6, N. Y.

America's Leading Distributor of AMMONIA

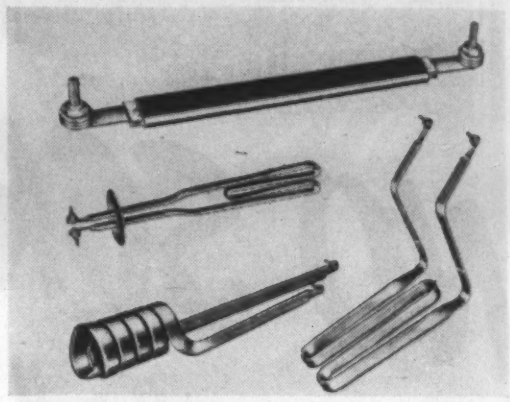
Barrett*

*Reg. U. S. Pat. Off.

New Materials and Equipment

ment for industrial heating such as is used with kettles, tanks, ovens, dies, driers and for immersion in liquids.

Said to provide flat surfaces for contact heating and a thin section for convection and air flow, the new unit is a rugged



The new type heating unit provides flat surfaces for contact heating and a thin section for convection and air flow.

structure, readily bent and formed. The 5/32-in. thick flat surfaces promote efficient radiation effects and can be supplied with self-regulating characteristics where their wattage will vary inversely with the heater temperature. They are proof against sparking or arcing through the sheath. Copper and steel are standard sheath materials, although other alloys or plating and various coatings can be supplied.

A variety of terminals are available or the heaters can be brazed or welded into various fittings or provided with holddown straps or brackets.

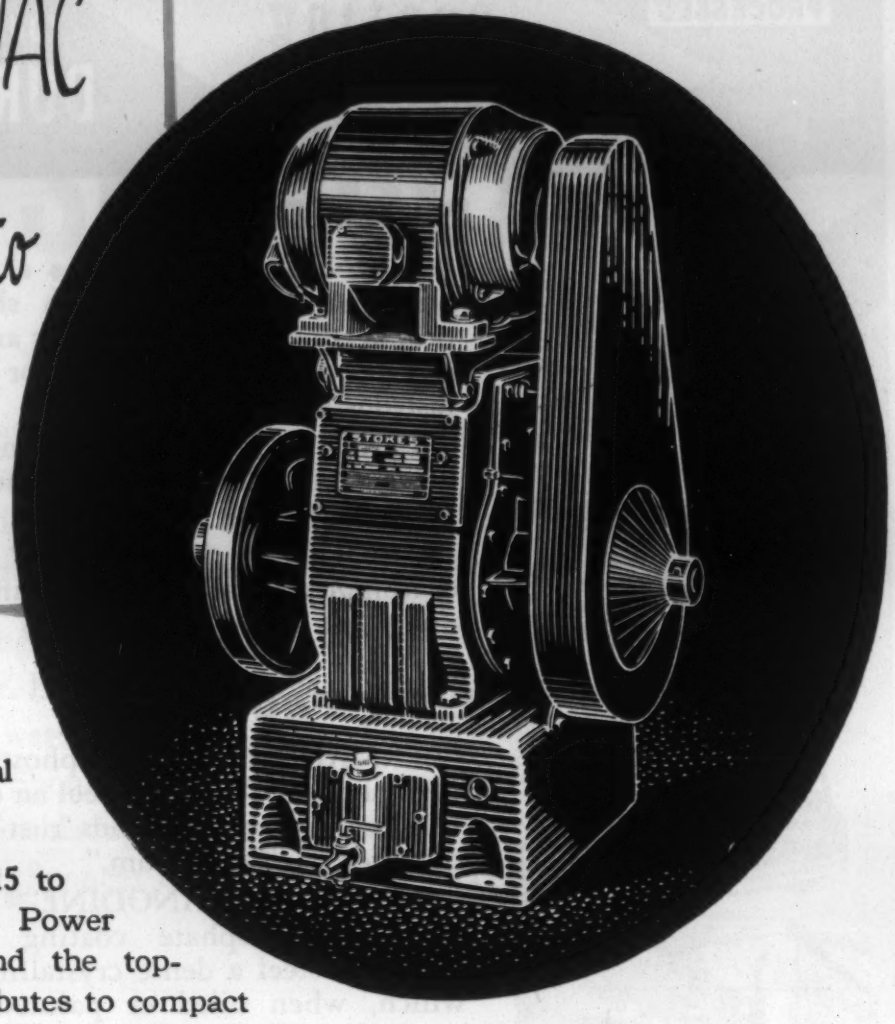
Lacquer Spray for Repainting or Touch-up Jobs

Powr-Pak, Inc., 1480 Barnum Ave., Bridgeport, Conn., has announced the development of a fast drying, color lacquer spray formulation for repainting or touching-up machinery and equipment that is shipped broken down and assembled at its destination.

An industry-wide check revealed most pieces of equipment shipped in such a manner required considerable repainting after it had been assembled and installed. In many instances, when special attachments were added, the part was left unpainted, or painted a different color from the original factory finish.

The company has designed and built special equipment for packaging Aerosol lacquer in any quantity and color. As a service to machinery and equipment manufacturers, Powr-Pak has organized a color-

STOKES MICROVAC PUMPS...are basic to Vacuum Processing



High volumetric and mechanical efficiency make these famous pumps economical and reliable units in any vacuum system.

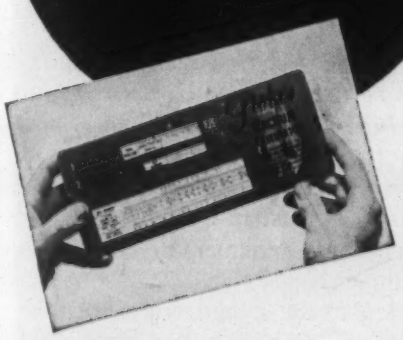
Capacities of Stokes Microvac Pumps run from 15 to 500 cfm . . . pressures to 10 microns absolute. Power consumption is low and the top-mounted motor contributes to compact design requiring minimum floor space.

Lubrication of the four moving parts (including the exhaust valve of corrosion-resistant Teflon) is fully automatic. There are no stuffing-boxes or grease fittings, and no packing.

Parts are precision-finished, standard and interchangeable. Freedom from wear assures years of trouble-proof service.

Stokes is the only manufacturer of equipment for complete vacuum systems, including Microvac mechanical pumps, oil diffusion pumps, McLeod Gages and Vacuum Valves.

Send for FREE Stokes Vacuum Calculator. This slide rule determines needed pump capacity for any job...shows Centigrade to Fahrenheit conversion. Other useful conversion tables and scales on reverse of rule.



Consult with Stokes on the application of vacuum to vacuum sintering, melting, de-gassing, heat treating, inert gas purging, vacuum metallizing, and to other applications in which vacuum deserves exploration.

STOKES

STOKES MAKES

Plastics Molding Presses,

Industrial Tabletting

and Powder Metal Presses,

Pharmaceutical Equipment,

Vacuum Processing Equipment,

High Vacuum Pumps and Gages,

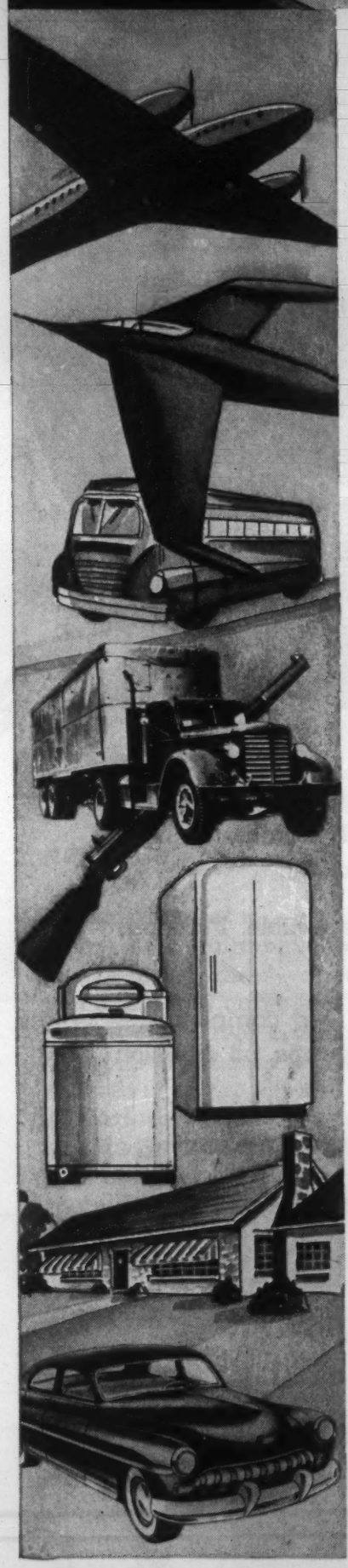
Special Machinery

F. J. STOKES MACHINE COMPANY, 5972 TABOR ROAD, PHILADELPHIA 20, PA.

CHEMICALS
ACP
PROCESSES

phosphate coating chemicals

TO MAKE YOUR PRODUCT DURABLE



PAINT BONDING

"GRANODINE"® forms a zinc-iron phosphate-coating bond on sheet metal products—automobile bodies and fenders, refrigerator cabinets, etc.—for a durable, lustrous paint finish.

"LITHOFORM"® makes paint stick to galvanized iron and other zinc and cadmium surfaces.

"ALODINE",® the new ACP protective coating chemical for aluminum, anchors the paint finish and protects the metal.

RUST PROOFING

"PERMADINE",® a zinc phosphate coating chemical, forms on steel an oil-adsorptive coating which bonds rust-inhibiting oils such as "Granoleum."

"THERMOIL-GRANODINE"® a manganese-iron phosphate coating chemical, forms on steel a dense crystalline coating which, when oiled or painted, inhibits corrosion.

PROTECTION FOR FRICTION SURFACES

The oiled "THERMOIL-GRANODINE" coating on pistons, piston rings, cranks, camshafts and other rubbing parts, allows safe break-in operation, eliminates metal-to-metal contact, maintains lubrication and reduces the danger of scuffing, scoring, galling, welding and tearing.

IMPROVED DRAWING AND COLD FORMING

"GRANODRAW"® forms on pickled surfaces a tightly-bound adherent, zinc-iron phosphate coating which facilitates the cold mechanical deformation of steel, improves drawing, and lengthens die life.

Send for descriptive folders and Government specifications chart on the above chemicals. Write or call for more information on these products, and advice on your own metal-working problem.

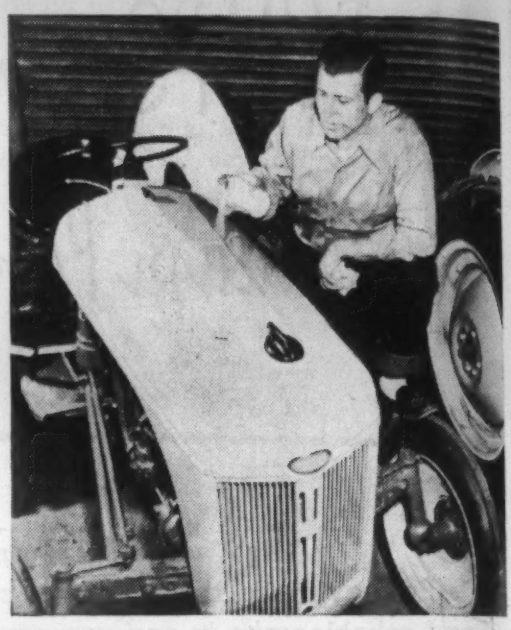
Pioneering Research and Development Since 1914

AMERICAN CHEMICAL PAINT COMPANY

AMBLER, PA.

Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

New Materials and Equipment



Here a tractor hood is being sprayed with the new color lacquer spray formulation for touching up jobs.

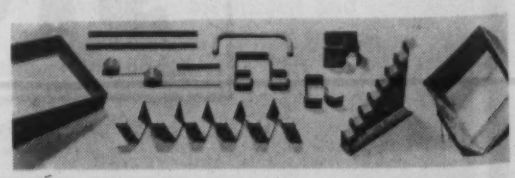
match department for preparing a color formulation to match the original factory color, and label the Aerosol package with a custom-made label for the individual manufacturer.

The unused paint will keep indefinitely, according to the company, and is reusable at any time until the content is completely exhausted.

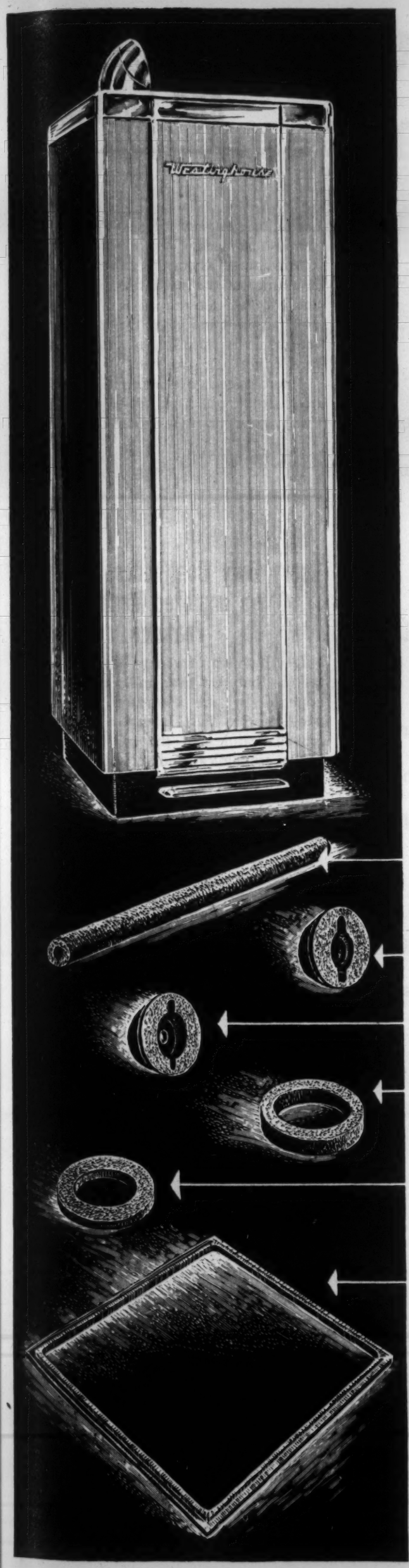
Improved Metal Forming Machine for Short Production Work

A new model Bendit metal forming machine has been announced by *Kilham Engineering, Inc.*, Plainville, Mass. Developed primarily for short production work, such as forming aircraft components, the machine forms sheet, strip and rod stock and small tubing into innumerable complex as well as simple shapes.

According to the manufacturer, the unit will form any desired radius from 1/32 in. to 5/8 in.; will make boxes up to 15 by 15 by 5 in., and will handle low ductile materials and plated metals without fracture or injury to the surface where the radius of bend is large enough to avoid cracking the paint. Bends or any angle,



These parts have all been formed by the new forming machine which forms sheet, strip and rod stock.



This water cooler
has a Longer, Better Life . . . works less each day

with **SPONGEX®**

CELLULAR RUBBER

Corrosion . . . deterioration . . . mechanical failure . . . repairs and parts replacement—an inevitable sequence wherever moisture condensation collects. It's a problem particularly troublesome in refrigerating equipment—but not in this Westinghouse water cooler!

Westinghouse has given its cooler a wardrobe of Spongex cellular rubber. Exposed cold surfaces—tubing, valves, even the waste water drain—are covered by custom molded Spongex parts. These Spongex parts not only prevent condensation but their insulating qualities increase refrigerating efficiency. For this cooler, Spongex means a longer, better, more efficient life.

The Westinghouse Wardrobe of SPONGEX

Tube insulator—
covers cold water tubing that supplies the drinking bubbler.

Regulator valve cap—
covers the cold surfaces of valve. Elasticity and flexibility of cap makes it easily removed for valve adjustment.

Water valve cap—
covers shut off valve controlling water flow to bubbler.

Basin drain insulator—
covers exposed end of the waste water drain.

Basin drain seal—
forms a water tight seal between bottom of the water cooler basin and top of the drain. The compressibility of Spongex compensates for variations in the clearance between basin and drain.

Door gasket—
forms an air tight seal for the door opening into the cold storage compartment. The gasket also seals off the insulating air space between the inner and outer panels of the door.

Perhaps Spongex can help better your product, too. We would be happy to hear from you.

The World's Largest Specialists in Cellular Rubber

THE SPONGE RUBBER PRODUCTS COMPANY

403 Derby Place, Shelton, Connecticut

yes...

G. O. Carlson, Inc. has built its reputation over the years by saying "yes" to users of stainless steel plate items—and by delivering chemical quality stainless to the precise requirements of industry . . . on time, as promised.

Today, our expanded specialized facilities are enabling us to say "yes" to a great diversity of critical requirements. Our entire production and scheduling are so organized that every usable pound of stainless steel is made available for the present emergency without waste.

Saying "yes" is much more involved than it has been for a number of years. When we can say "yes", we mean it.

Stainless steel is our only business . . . and we know it.

G. O. CARLSON, INC.

Stainless Steels Exclusively

200 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)

District Sales Offices and Warehouse Distributors in Principal Cities

New Materials and Equipment

including complete folds and partial bends, can also be made.

Advantages claimed for the machine are: it eliminates the need for expensive dies and intricate tooling; it is provided with positive stops and gages for accurate duplicating; it is open ended front and back for feeding long strip stock.

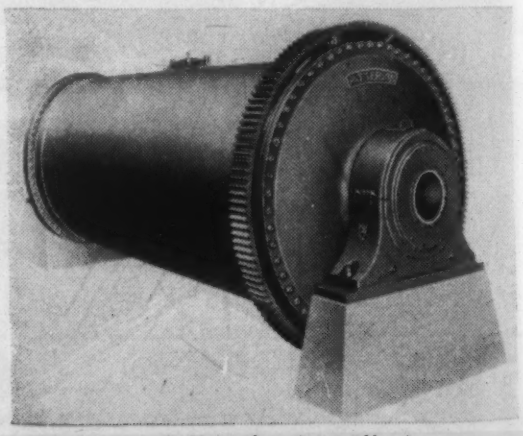
Interchangeable bending blades of soft steel are supplied, to be cut or sawed to size to meet job requirements.

Heavy Duty Continuous Tube Mill Offers Improved Mechanical Features

Development of a new heavy duty continuous ball or tube mill has been announced by the *Patterson Foundry & Machine Co.*, East Liverpool, Ohio. Improved features of the mill are said to insure economical and reliable continuous grinding operation under the most severe conditions, with costly shut-downs being entirely eliminated and maintenance expense reduced to a minimum.

Adaptable to fine or coarse grinding, wet or dry grinding, open or closed circuit grinding, the new unit can be used for pulverizing chemical raw materials, ceramic raw materials, minerals, and numerous finished products.

The manufacturer states that the mill can be used to deliver a finished product, or it can be used in conjunction with the company's classifying equipment of various types. Hollow trunnions are provided



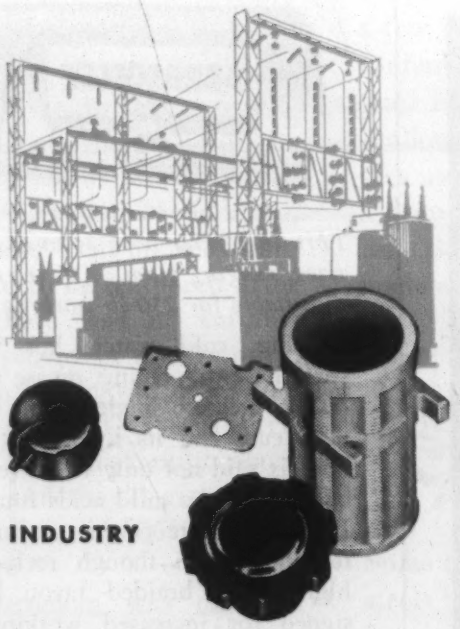
Continuous ball and tube mill sizes range from 2 ft in dia by 2 ft long to 10 ft in dia by 24 ft long.

for continuous feed and discharge of materials.

Among the principal design features are mill heads of cast steel construction, slightly conical in shape to provide maximum rigidity and strength with minimum weight. They are easly replaced and have turned and highly polished trunnions. The

When you need a versatile material

micarta is basic!



ELECTRICAL INDUSTRY

You'll find MICARTA across the board in this vital industry. For over 40 years, MICARTA has served as a basic material wherever electricity is generated or used . . . from central station applications to home appliances . . . as large fabricated panelboards or tiny punched radio and television parts.

MICARTA® can take any shape. It is a tough and resilient basic material . . . a plastic which can be machined, formed or molded to micro-fractions of an inch.

MICARTA is lighter than aluminum. Pound for pound, it has a greater compressive strength than structural steel. It cushions impact, resists heat and cold, outlasts metal in many punishing applications.

Here is an excellent insulator. It is a standard in panels, switch handles, separators...wherever electric current has to be isolated.

This versatile basic material fabricates easier and more economically than any metal. Do you have a place for it? Westinghouse Electric Corporation, MICARTA Division, Trafford, Pennsylvania.

J-06447

CORROSION

stopped *before* it starts

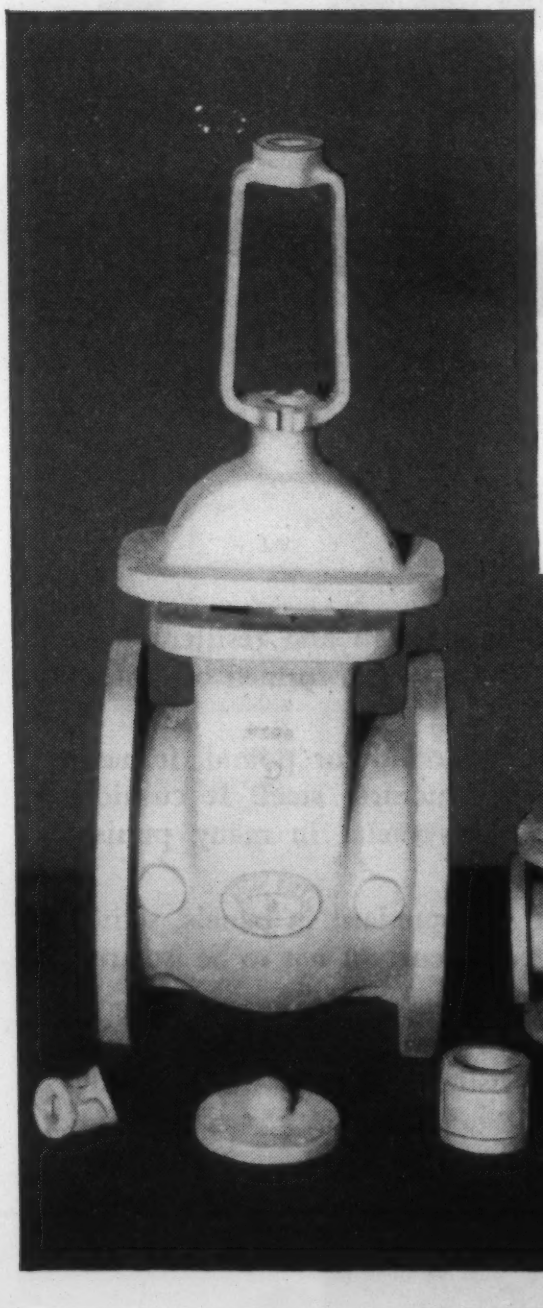
with Lebanon CORROSION-RESISTANT CASTINGS...

Stopping that metal-eating "glutton"—corrosion, before he even gets started, is something we've had a hand in doing for many years.

Stainless castings produced by Lebanon's exclusive processes have the *right* composition, the *right* uniformity and the *right* internal integrity to keep corrosion from taking its toll. Our twenty years of experience in developing and producing castings that are resistant to many corrosive agents, mean that we can accurately anticipate your needs.

If your problem is corrosion, bring that problem to our engineers... they'll help you defeat this enemy before he has a chance to start. Lebanon REFERENCE CHARTS give complete information on the types of material available... write for your copies today.

LEBANON STEEL FOUNDRY
Lebanon, Pennsylvania
"In the Lebanon Valley"



Valve Bodies and Fittings are typical of the types of castings made by Lebanon to be used in services where corrosion is a factor.

LEBANON ALLOY AND STEEL Castings

CIRCLE L

New Materials and Equipment

mill shell is of welded steel drilled for the installation of the replaceable cast iron or steel lining. Where materials must be ground with a minimum of metallic contamination, the mill can be lined with buhrstone or Patterson acid-resistant Porox blocks.

The mill is driven through a heavy "T" section girth, or ring gear, split and reversible to provide maximum gear life. Streamlined main mill bearings are large and rigid. Various bearing materials, such as heavy duty babbitt, replaceable bronze sleeves or fabric plastic sleeves are available to suit the particular application.

Industrial-Type Hose Is Oil and Abrasion Resistant

A new, multi-purpose, industrial-type hose, which is said to be both oil and abrasion resistant, has been announced by *Mercer Rubber Corp.*, 66 Reade St., New York, N. Y.

Abrasoflex Hose can be used for any of eight industrial applications, including air,

This industrial hose is available in seven sizes, ranging from 3/16 in. to 1 in. I.D., suitable for 250-lb working pressures.

welding, cold water, hot water, paint spraying, oil spraying, grease and gasoline.

The greatest single enemy of rubber is petroleum and its by-products. The new hose is said not only to be resistant to it, but also to the mild acids found in water. Its smooth bore permits an uninterrupted, fast flow even though reeled, while its high-tensile, braided rayon body is designed for increased working pressures, and to withstand normal abrasion of the body.

Presses Feature Illuminated Beds To Eliminate Die Breakage

Designed to blank, draw, form and pierce sheet metal parts, new presses offered by *Thunder Bay Manufacturing*

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

In the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

Fresh-roasted Chisels Halt Costly Breakage

A foundry in the Middle West had long depended on a rule-of-thumb heat-treater to harden the large number of chisels they used daily. One day he quit abruptly. No great concern was felt about his departure—until they began to break as many as 300 chisels in one day.

A trouble-shooter, hurriedly summoned, soon traced the appalling breakage to the as-quenched brittleness of the chisels. The departed heat-treater hadn't revealed how he relieved this condition. The trouble-shooter went on to explain that the chisels had to be tempered after hardening. But there was no suitable heat-treating equipment in the foundry. Suddenly he hit on the answer. "Tell you what—you can get one of those electric turkey roasters. They cost only about twenty-five bucks and they'll give you a tempering range of about 250 to 500 F. Get what you need."

The division foreman was dubious. How could roasting the chisels do any good? But he bought a roaster and put it on the job. To his surprise it cured the breakage. In the first week they averaged only one broken chisel a day. The roaster paid for itself in no time.

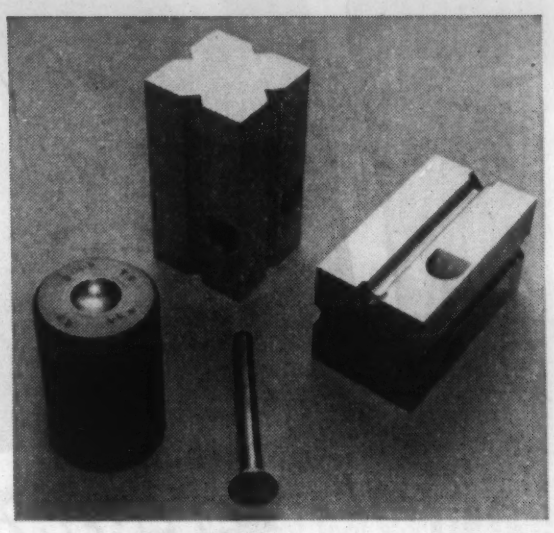
Many tools and dies fail because they haven't been tempered after hardening. Not holding tools at the tempering temperature long enough causes the same kind of trouble. Another important point: always temper tools before they cool down to room temperature. Usually it's best not to let them cool below 150 F.

Cold-heading Die Steel Takes a Real Beating

Maybe you've seen a cold-heading machine in action, forging bolts, rivets, screws, and other products at high speed. The tools and dies which do the cutting, gripping, and heading have to be seen at work to be appreciated. Minute after minute, day after day, they withstand continuous terrific pounding.

Good cold-heading die steel—used for the solid, open, and header types of dies—must have a hard, long-wearing surface, reinforced by a tough core. The hard, wear-resisting case must be deep enough to prevent sinking or upsetting and tough enough to absorb heavy pounding without chipping or spalling.

Cold-heading die steel is one of our special-purpose tool steels. It took quite a few years to work out the right carbon content, depth of hardness, and grain size. For example, we've found that a shallow-hardening steel is best for header dies up to 2-in. diameter; for larger dies a deep-hardening steel gives longer service. Both are fine-grained tool steels, made ever so carefully to insure the ultimate in cleanliness and freedom from injurious defects.



These gripper and header dies of Bethlehem Cold-Heading Die Steel have the ideal combination of hard surface and tough core for cold-heading thousands of bolts each day.

We call it Bethlehem XX Cold-Heading Die Steel. It's really tops for this kind of punishing service. Like to know more about it? Address your request to our Publications Department, Bethlehem, Pa. Ask for Booklet 261.

Our Tool Steel Engineer Says:

A modified oil-quench gets rid of scale on air-hardening tool steels

Some toolmakers object to air-hardening steels because a thin, adherent scale may form during the air-quench. Avoiding this scale is really easy.

Quench the tool or die in oil until it just loses color . . . 900 to 1000 F . . . then cool it in air to about 150 F, followed by the usual tempering operation. The oil-quench will "throw" the scale. But the tool won't crack, because air-hardening steels do not begin to transform, or harden, until they reach 400 F or less.

However, air-hardening steels must *not* be quenched in oil long enough to cool them down below the temperature at which transformation takes place. If this precaution is ignored, cracking of the tool is likely to result.

Air-quenching, of course, results in the minimum amount of distortion.

Bethlehem ULTRASONIC TESTED **Tool Steel**

Only RIGIDIZED METALS COULD DO THIS IMPORTANT JOB Right

Rigidized design-strengthened, textured **Metals**

PROBLEM:—Standard Duplicating Machines Corporation, Everett, Massachusetts, needed an efficient wick guide for its Coronet Duplicator. This guide was to have ready-made capillary action in order to channel excess duplicating fluid into tanks instead of permitting it to pile up and flood the wick's edge.
SOLUTION:—Three-dimensional design-strengthened RIGIDIZED METAL was selected. The "wavy-line" design in the 5-WL pattern was ideal for directing the fluid into the correct receptacles because of its capillary action. The ready-made texture of the metal proved to be cheaper than a stamping operation. This lightweight, high-rigidity metal has unlimited utility applications that have proved valuable in product fabrication. What's your particular problem? Perhaps RIGIDIZED METALS is **your** solution, too.

Background is Pattern 5-WL.

U. S. and Foreign Patents

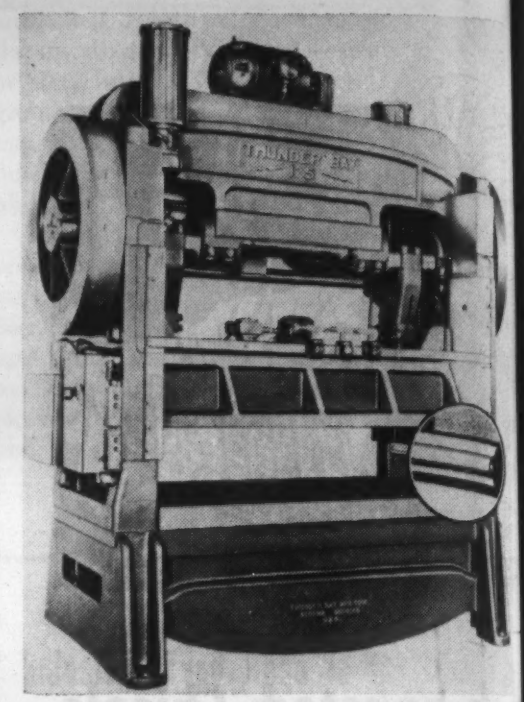
WRITE ON YOUR COMPANY LETTERHEAD FOR A COPY OF THE RIGIDIZED METALS CONSERVATION HANDBOOK Today

Rigidized Metals Corporation

66012 OHIO STREET • BUFFALO 3, N. Y.

Offices in Principal Cities in the U. S. & Canada

New Materials and Equipment



This press performs a wide variety of uses—from the cutting and perforating of light materials to blanking, forming and drawing of heavy gage sheet metals.

Co., 227 Iron St., Detroit 7, incorporate a new feature—illuminated press beds which are claimed to eliminate die breakage.

Fluorescent tubes, efficiently placed at each end of the press bed, shed sufficient light to give the operator full vision at all times for his task. Additional features include: bed drilled for die cushion installation; ram length equal to bed length; no gib interference; and large gaps in columns for feeding of coil stock from the sides.

Available in a complete range of capacities from 125 to 400 tons, and in a wide range of bed sizes, shut heights and strokes for a variety of uses, the presses are built to perform steadily and offer long life.

New Machine Efficiently Removes Buffing Compound

The efficient removal of buffing compound from polished vacuum cleaner parts is said to be effected through the use of a new machine manufactured by the *Industrial Washing Machine Corp.*, New Brunswick, N. J.

With a high production rate of 900 sq ft per hr, model CT 36x10 performs the difficult task of completely removing caked buffing compound from parts while saving the labor of three employees. The

"no more GAMBLING on tool steel selection"

[⅓ actual size; Selector is in 3 colors]

Here's how it works:

To use the Selector, all you need know is the characteristics that come with the job: type and condition of material to be worked, the number of pieces to be produced, the method of working, and the condition of the equipment to be used.

FOUR STEPS—and you've got the right answer!

1. Move arrow to major class covering application
2. Select sub-group which best fits application
3. Note major tool characteristics (under arrow) and other characteristics in cut-outs for each grade in sub-group
4. Select tool steel indicated

That's all there is to it!

Here's an example:

Application—Deep drawing die for steel

Major Class—Metal Forming—Cold

Sub-Group — Special Purpose

Tool Characteristics—Wear Resistance

Tool Steel—Airdi 150

One turn of the dial does it!

And you're sure you're right!!

Since the first announcement, hundreds of tool steel users have received their CRUCIBLE TOOL STEEL SELECTORS. The comments received indicate that this handy method of *picking the right tool steel right from the start* is going over big.

"Handiest selector I've ever seen"

"No more gambling on tool steel selection"

"You're right, the application should dictate the choice of the tool steel" . . . and many, many more favorable comments.

You'll want your CRUCIBLE TOOL STEEL SELECTOR. It uses the only logical method of tool steel selection—begin with the application to pick the right steel! And the answer you get with one turn of the Selector dial will prove satisfactory in every case, for the CRUCIBLE TOOL STEEL SELECTOR covers 22 tool steels which fit 98% of all Tool Steel applications. ALL the tool steels on the Selector are in Warehouse Stock . . . that means when you get the answer, you can get the steel . . . fast!

Write for your Selector today! We want you to have it, because we know you've never seen anything that approaches your tool steel problems so simply and logically. Just fill out the coupon and mail. Act now! CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, New York 17, N. Y.

Crucible Steel Company of America
Dept. M, Chrysler Building
New York 17, N. Y.
Gentlemen:
Sure! I want my CRUCIBLE TOOL STEEL SELECTOR!

Name_____ Title_____

Company_____

Street_____

City_____ State_____

CRUCIBLE first name in special purpose steels

TOOL STEELS

Non-Porous

Dense

Moisture Proof

Strong

An ideal material for many applications such as railroad signals, radio receiving sets and telephone fuse blocks, VITROLAIN can be made to specifications as low as 0.25% absorption. If still lower absorption is required, it can be specially processed so as to give a moisture-proof surface, impermeable to atmosphere moisture. It is not affected by dilute acids or bases. It is superior to commercial grade in dielectric strength.

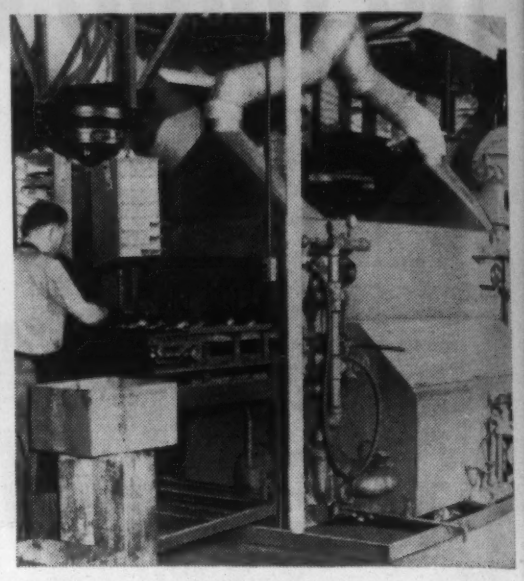
Send for NEW Star Brochure

★ HUMIDOLAIN
★ LAVOLAIN
★ THERMOLAIN
★ VITROLAIN
★ NU-BLAC
★ COMMERCIAL WHITE

The STAR PORCELAIN COMPANY

MUIRHEAD AND JAY AVES. TRENTON, N. J.

New Materials and Equipment



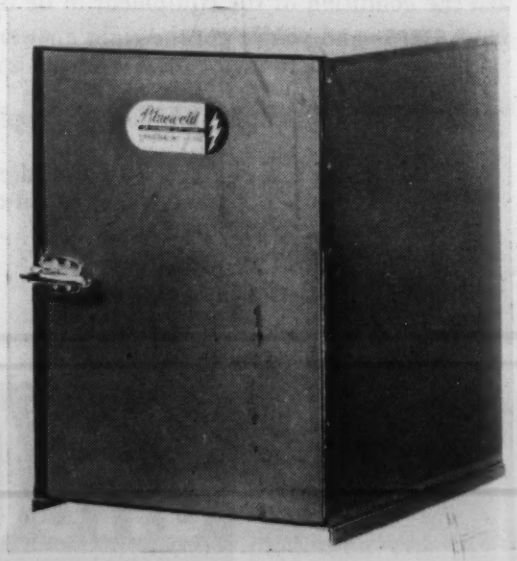
This machine completely removes caked buffing compound from parts.

machine, which occupies a small area, is heated by steam.

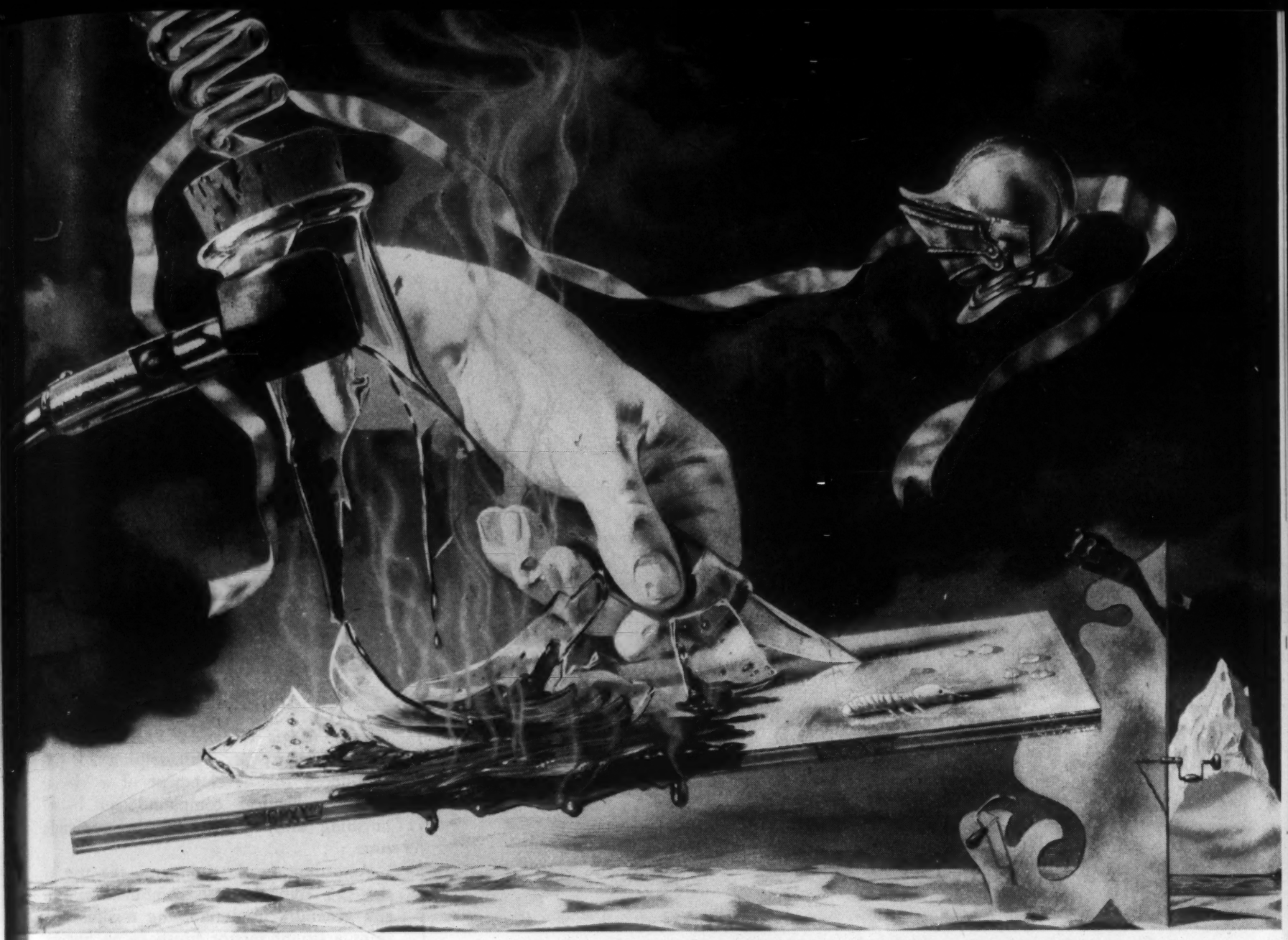
Its operation is completely automatic—it washes, rinses and dries the work and delivers it ready for color buffing.

New Stabilizer Safeguards Low Hydrogen Electrodes

With the rapidly increasing use of the low hydrogen welding process, it has become necessary to find some means of protecting the electrodes from atmospheric moisture from the time they are removed from the moisture-proof container until they are put into use. A compact, efficient, moisture-content stabilizer has been introduced by *Fred C. Archer, Inc.*, 606 W.



This stabilizer for low hydrogen electrodes can be located at any point convenient to the welding operation because of its compact design.



A Georgia-Pacific "new dimension" in plywood

WE PUT IT THROUGH A WITCH'S BREW...

"Double, double, toil and trouble." Macbeth's witches couldn't have conjured up more torturous tests to prove that Georgia-Pacific's GPX plastic-faced plywood can turn in performance results that put most other materials to shame.

Boiled in water four hours, dried, and boiled again . . . immersed in an acid solution . . . subjected to sub-zero cold . . . scratched a hundred thousand times by a razor . . . subjected to molds, fungi, termites, marine borers . . . through these tests and many more, GPX comes through unscathed. Yet armor-hard, satin-smooth GPX panels are easy to handle and fabricate.

GPX is a modern material that is blazing new trails in industry and construction. In foundry match plates, photo lab equipment, testing tables, drying boards in leather factories, catwalks in machinery installations, GPX is slashing labor and material costs. Write for the GPX descriptive folder, or get in touch with your nearest Georgia-Pacific office.

GPX DATA

Check these properties

GPX plastic-faced plywood is a superior exterior grade Douglas Fir Plywood, bonded and surfaced with a layer of phenolic resin plastic under heat and pressure that makes the hard, dense surface part of the plywood itself.

✓ **Weatherproof** . . . unaffected by sun, rain, or freezing.

✓ **Waterproof** . . . 20 times more resistant to water absorption than ordinary plywood.

✓ **Abrasion Resistant** . . . 10 times as abrasion resistant as ordinary plywood in dry tests; 30 times when wet.

✓ **Chemical Resistant** . . . resists hydrocarbons, salt, soap, hydrochloric acid, sulphuric acid, organic solvents, etc.

✓ **Vermin Resistant** . . . armor-hard surface resists termites, marine borers, mold and fungi.

✓ **Smooth** . . . remarkably smooth, free from grain-raise or checking.

✓ **Strong** . . . stronger than steel (weight for weight). Plastic surfacing increases stiffness factor.

✓ **Easy-to-Work** . . . easy to saw, drill, sand, nail, rivet, glue or paint.

✓ **Variety of Grades and Weights** . . . comes in four grade types, five thicknesses and a range of surface overlay weights. Standard panel size, 4 x 8 feet. Longer lengths on special order.

Send for full details today!

GEORGIA—PACIFIC

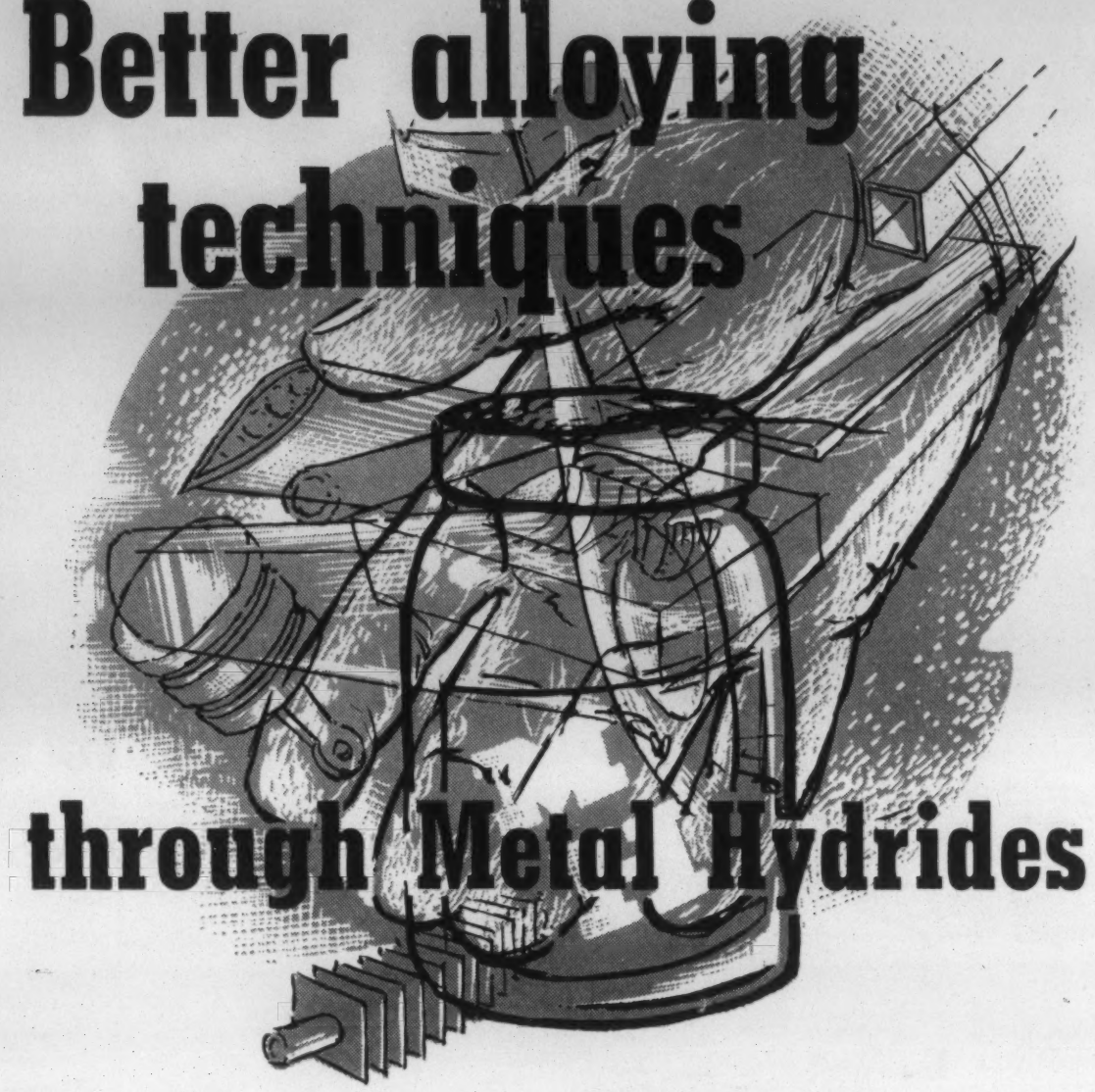
PLYWOOD COMPANY

613 North Capitol Way, Olympia, Wash.

OFFICES OR WAREHOUSES IN: Augusta, Birmingham, Boston, Chicago, Columbia, Louisville, Memphis, Nashville, Newark, Olympia, Orlando, Philadelphia, Pittsburgh, Raleigh, Richmond, Savannah.

DOUGLAS FIR PLYWOOD • HARDWOOD PLYWOOD • GPX • SOUTHERN & WESTERN LUMBER • DOORS

Better alloying techniques through Metal Hydrides



Finer grain structure — higher heat resistance — increased tensile strength — only a few of the advantages gained when master alloys of titanium and zirconium are added to your metal products. Now produced commercially by Metal Hydrides Incorporated, titanium and zirconium are available as powders, sintered granules, fused lumps or hydride powders.

In addition to these, Metal Hydrides also produces binary master alloys of Zr-Cu, Cr-Ni, Zr-Ni, Zr-Mg. All are available in a wide range of composition as either powder (325 mesh) fused lumps, or sintered granules.

Can these amazing new metals help you? Find out by writing Metal Hydrides Incorporated today for complete details.

✓ Check these unusual advantages of MH Metal Hydrides.

- ✓ **Provide master alloys for direct use**
- ✓ **Fortify and refine grain structures**
- ✓ **Simplify many alloying processes**
- ✓ **Zirconium hydride provides gettering — safest for the removal of gas from vacuum tubes**
- ✓ **Zirconium — a source of heat for elements in photo flash bulbs**

Titanium, Lithium, Aluminum, Zirconium, Tantalum, Sodium, Barium and Calcium Hydrides

MH

METAL HYDRIDES INC.
12-24 Congress Street
BEVERLY, MASS.

New Materials and Equipment

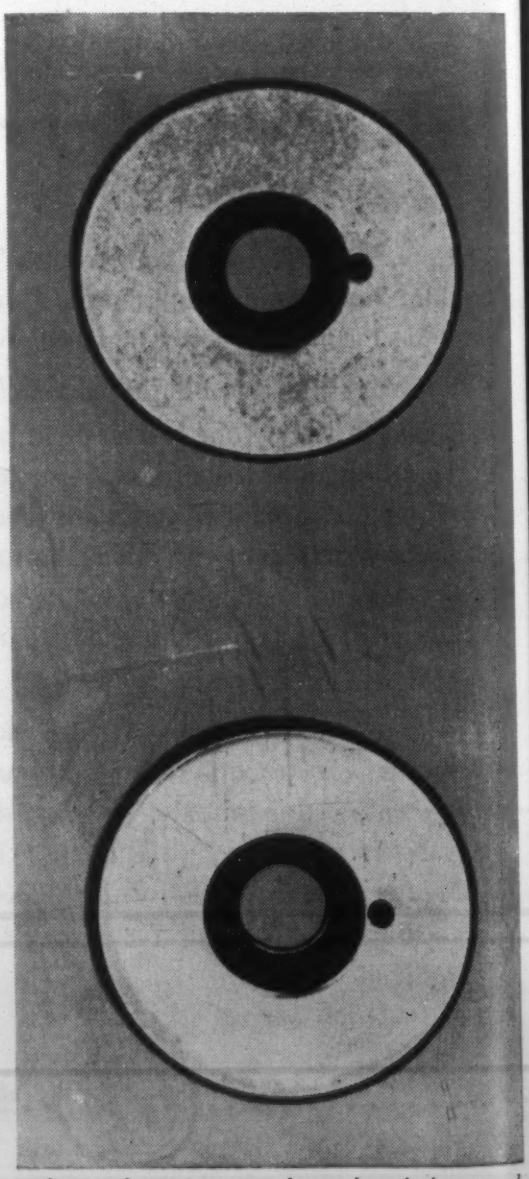
Wisconsin Ave., Milwaukee 3, which is said to provide the desired protection of low hydrogen welding rods at point of use.

Known as the Blueweld Lo-Hydrogen electrode stabilizer, the unit stores 400 lb of electrodes and, because of its size and compact design, can be located at any point convenient to the welding operation.

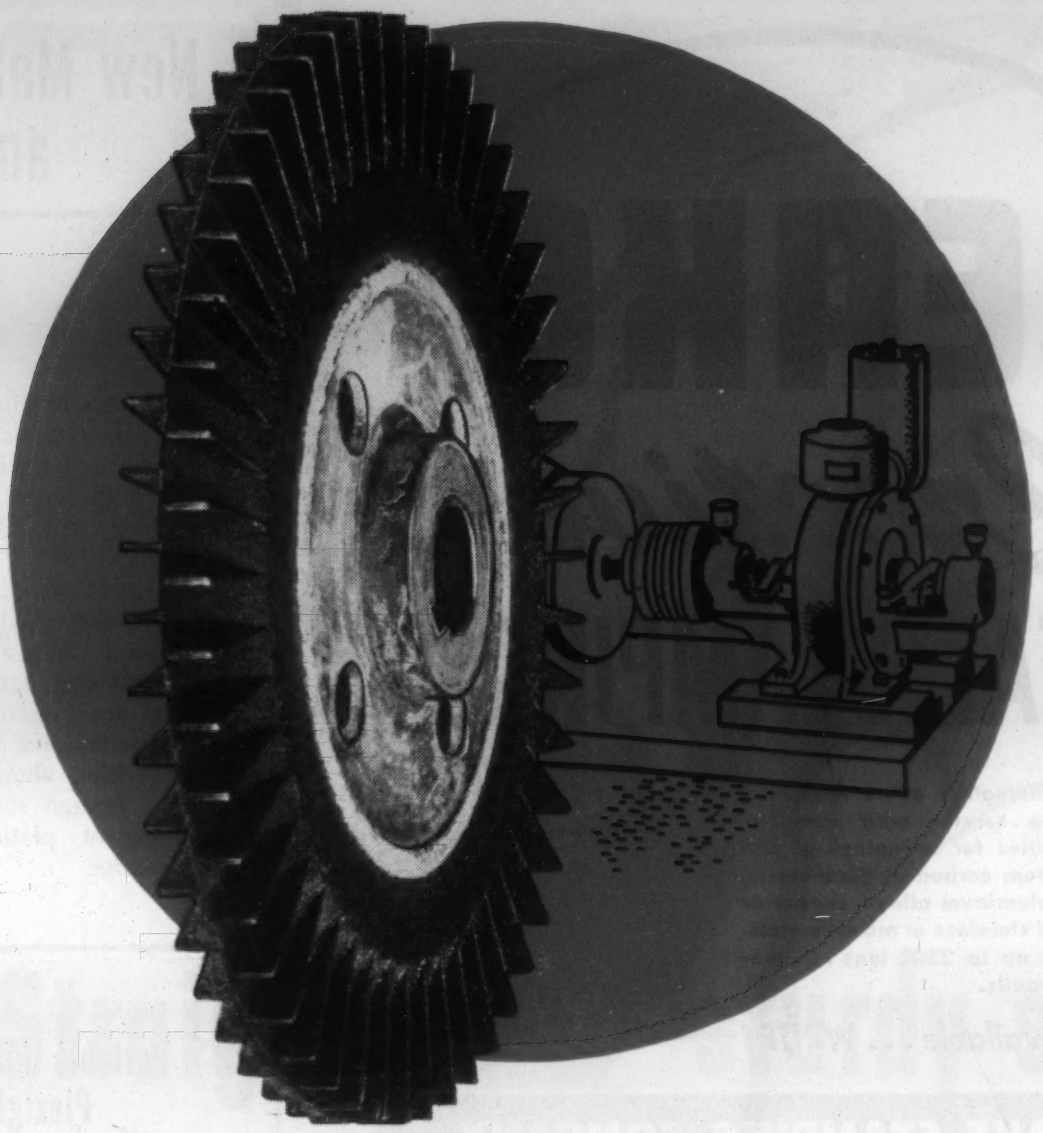
Chemical Compound Speeds Up Barrel Finishing

Blue Magic Chemical Specialties Co., 2135 Margaret St., Philadelphia 24, has announced the development of a special purpose chemical compound for barrel finishing alloy steel parts in minimum time.

According to the company, the use of the C-5 compound in combination with any generally used tumbling medium enables a bright mirror finish to be put on



Shown here is a steel washer before and after burnishing for 2 hr with the new compound for barrel finishing.



Found:

The 2% that cured a Pickled Pump

How years of N-B-M Metallurgical experience paid off by solving a severe problem of corrosion

When a vinegar producer suddenly starts having frequent pump failures due to extreme impeller corrosion, it's pretty evident that something unusual is going on . . . particularly when the same pump had been used successfully for years. The pump manufacturer sent an engineer to the installation . . . and found that *concentrated* vinegar was being pumped, instead of *diluted* vinegar as before. Impellers in some cases were lasting only 1 week.

The pump manufacturer came to us with the facts—and our Metallurgical Department was immediately put to work on the problem.

Result? **In a matter of days, impellers of a new alloy were on their way with a slight but important alloy change . . . the addition of 2% nickel. These impellers now last 18 months to 2 years—longer than they ever had before!**

We're proud of examples like this . . . because they show how effectively our facilities for Research and Engineering — combined with 75 years of practical application experience—make money-saving solutions to problems on . . .

Non-Ferrous Bearings and Castings—
As-Cast or Machined

Bronze Bars—
As-Cast or Machined;
Cored, Solid, Hexagon

Babbitt Metals—
For every type of
bearing service

AMERICAN Brake Shoe COMPANY

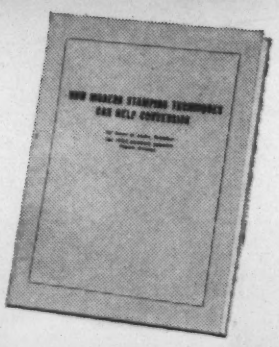
NATIONAL BEARING DIVISION

4929 Manchester Avenue • St. Louis 10, Mo.

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

LEAKE *Creative* METAL STAMPINGS

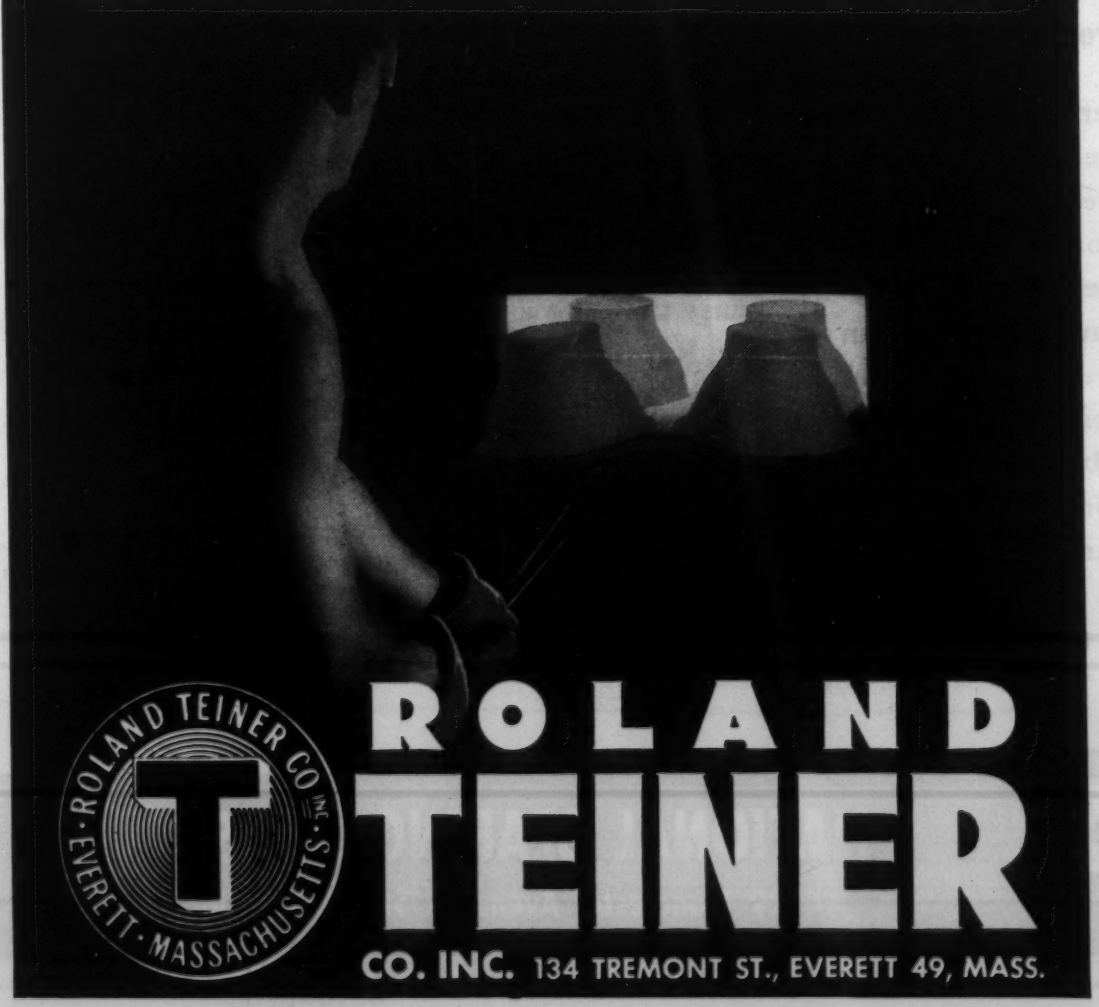
The LEAKE Organization offers designing and engineering service with complete production facilities for stampings of any size or shape from carbon or alloy steels, magnesium or aluminum alloys, copper or brass alloys, and stainless or monel metals. Press capacities up to 2500 tons . . . mechanical or hydraulic.



Literature available . . . WRITE!

THE LEAKE STAMPING COMPANY
MONROE, MICHIGAN

FILLING A GOVERNMENT ORDER. Stainless steel jet engine components are heated in annealing oven, prior to re-spinning. An example of the all-gage — all-metal — any quantity — spinning capacity available at Teiner. ***Write for newest color brochure* 51M.**



ROLAND TEINER CO. INC. EVERETT · MASSACHUSETTS

ROLAND TEINER
CO. INC. 134 TREMONT ST., EVERETT 49, MASS.

New Materials and Equipment

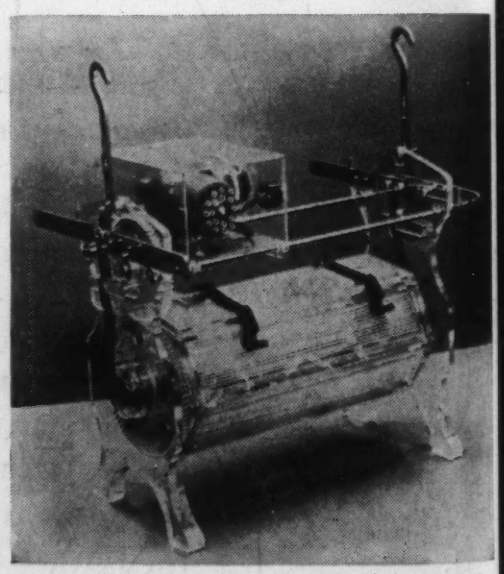
steel parts in time cycles of 20 to 40 min. Also, in certain applications the compound can be used for both roughing and finishing to produce low micro inch surface readings, true color and perfectly uniform results.

Blue Magic compound is a non-dusting, soapy, concentrated powder that has no obnoxious odor and is not irritating to the skin. It is said that detergency and rinsibility are outstanding characteristics and that parts leave the tumbling barrel free from chips, abrasives, oil traces and any other foreign matter that might impair subsequent plating, painting or other operations.

Portable Plating Barrel Has Plexiglas Cylinder

A new development of the *Hanson-Van Winkle-Munning Co.*, Matawan, N. J., is the Mercil portable plating apparatus with Plexiglas cylinder, said to be particularly adapted to the processing of small parts.

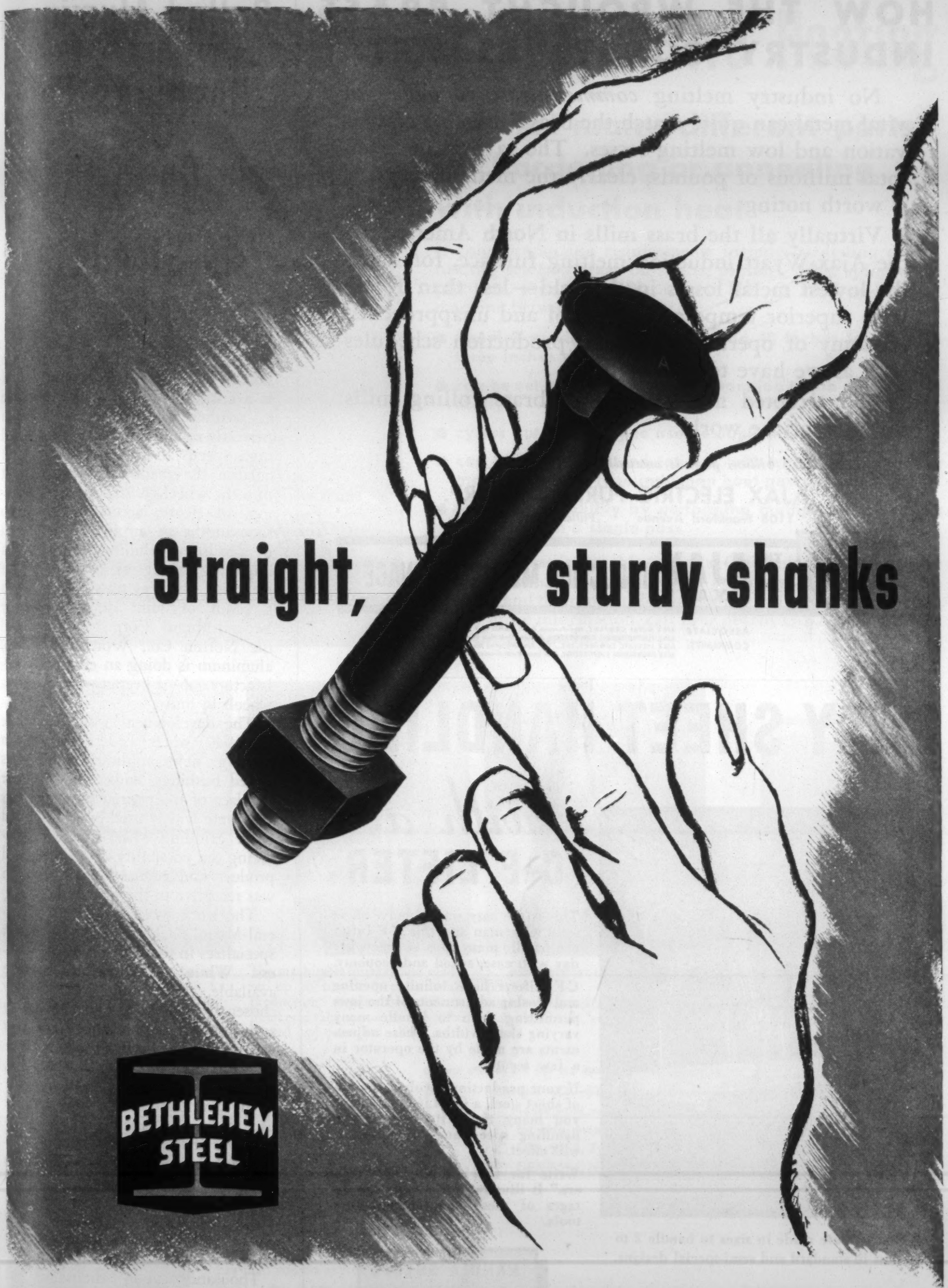
This equipment, which is made with cylinders 6 in. in dia by 12 in. long O.D.



This plating apparatus is particularly adapted to the processing of small parts.

and 8 in. in dia by 18 in. long is designed to enable the user to process small parts efficiently.

The entire unit is light in weight and can be easily handled. A rheostat is included so that the cylinder can be operated at various speeds. Cylinder, legs and gears are of Plexiglas; the motor is 1/15 hp, suitable for operation on 110- or 220-v, single phase, 60-cycle power circuit. It can be used in either acid or alkaline solutions, providing the temperature of the bath does not exceed 180 to 185 F.



Bethlehem supplies every type of Fastener

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field—less than 1%—with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

The accepted melting tool in brass rolling mills throughout the world.

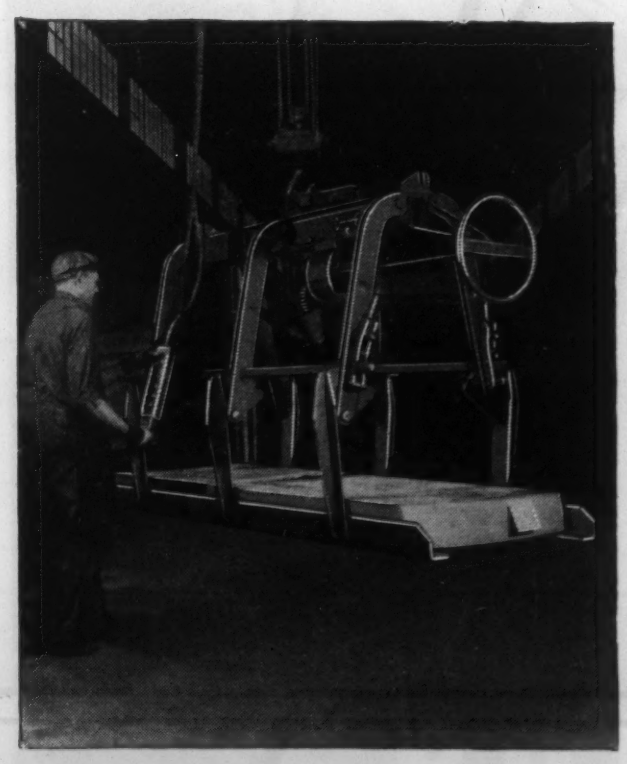
** Upwards of 5 billion pounds annually.*

AJAX ELECTRIC FURNACE CORP.
1108 Frankford Avenue • Philadelphia 25, Pa.

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES:
AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

EASY SHEET HANDLING *with a* C-F LIFTER



C-F Lifters are made in sizes to handle 2 to 60 tons in standard and semi-special designs.

This is the easy way to move sheet steel. One man and this C-F Lifter can handle many tons of sheets per day with ease, speed and economy.

C-F Lifters have infinite opening and closing adjustments of the jaws permitting them to handle many varying sheet widths. These adjustments are made by the operator in a few seconds.

If your production involves the use of sheet steel, a C-F Lifter will save you many times its cost in the handling speed and economies it will effect.

Write for the bulletin "C-F Lifters." It illustrates the many advantages of these material handling tools.

CULLEN-FRIESTEDT CO.
1314 S. Kilbourn Ave., Chicago 23, Ill.

HANDLE SHEETS with C-F LIFTERS

Rolled Aluminum Bushings Low in Cost, High in Strength

● LIKE THE HUB of any wheel, the hole in the center of a grinding wheel is a critical point. It must be made to accurate dimensions and remain perfectly round under heavy load and high speeds to preserve the perfect balance the manufacturer has built into the wheel. A sturdy metal bushing, or sleeve, accurately made to thousandths of an inch is essential in precision grinding to obtain a mounting fitting as closely to the grinding wheel as possible. Now, as a result of joint development by Federal-Mogul Corp., Detroit, and the Norton Co., Worcester, Mass., aluminum is doing an eminently satisfactory job of keeping the grinding wheels in line.

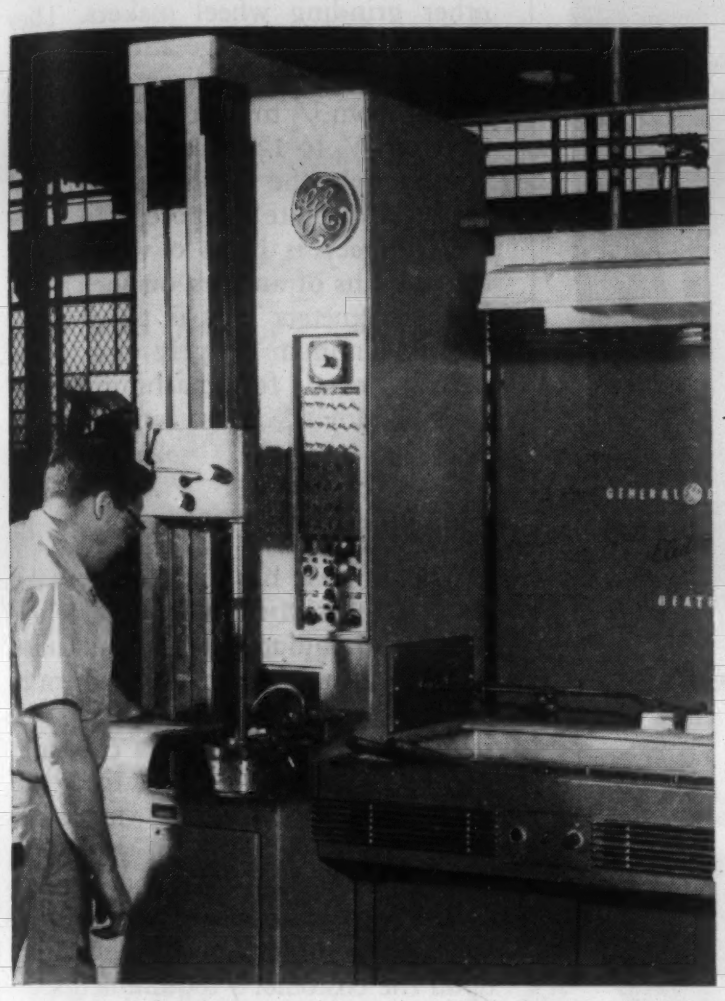
The development was begun late in 1949 when Federal-Mogul, in seeking new applications for its rolled bushings, suggested their use in place of the poured lead bushings that were widely used by Norton and other grinding wheel makers. Foreseeing the possibility of an improved product and reduced costs, Norton was receptive to the proposal.

The work was carried on in Federal-Mogul's Cleveland plant, which specializes in the rolled bushing process. While many materials were available, aluminum was quickly chosen for its low cost, machinability and strength. Approximately a year was required to perfect the new product. Intricate dies had to be built, and the problems that usually arise in the development of a new product had to be overcome. A major problem was that of making the aluminum adhere tightly when pressed into the grinding wheel. This was solved by Norton engineers, who designed and patented a grooved outer surface of the bushing to grasp the abrasive firmly.

Thousands upon thousands of aluminum bushings of various designs are now produced by Federal-Mogul every month for Norton and

(Continued on page 176)

New G-E Machine for Progressive Heating



handles many different parts for hardening or annealing with induction heat

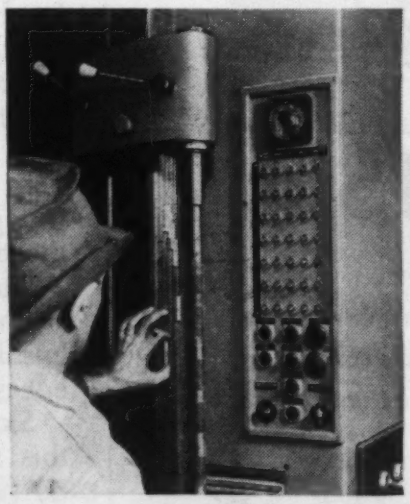
If your production requirements include hardening or annealing selected areas on shafts, pinions, rods, spindles or plungers, then you need the new HM 40 PV heat-treating machine because it . . .

- **handles a wide range of work to 40 inches length and three inches diameter**
- **can be set up or changed over from job to job quickly and easily**
- **cycles automatically to assure duplication of results**
- **can be easily adapted for use with either electronic or motor-generator type induction heat power source**
- **increases flexibility by performing multiple heat-treating operations in a single pass**

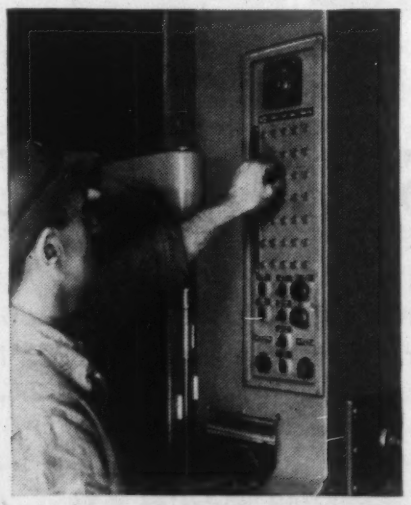
This versatile machine and a G-E induction heater are ideally suited for shops where a variety of parts must be treated, and their quantities do not justify individual fixturing.

For more information, call your nearby G-E Sales Office, or clip the coupon below.

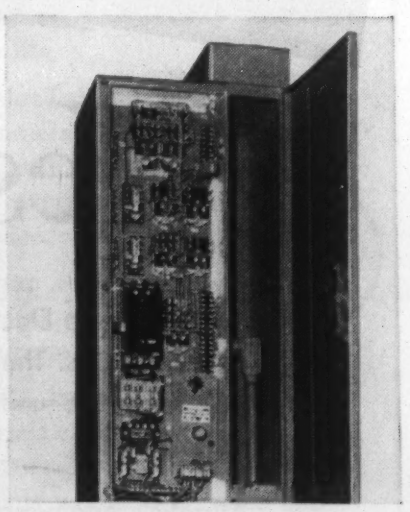
Quick reloading is possible because the controls are so convenient for the operator. Centers are spring-mounted, and either standard point or cup-type can be used.



The machine is quickly and easily set up to handle large or small production requirements. Place numbered tabs opposite areas to be heated and quenched, then . . .

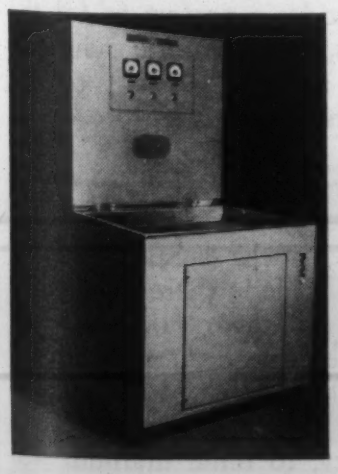


. . . finish the set-up by setting the proper toggle switches on the convenient control panel for heat, quench, dwell and rotate functions.



After set-up or change-over is finished, the Thy-mo-trol* control automatically carries out the cycle again and again to give uniform heat-treating results.

** Registered trade-mark, General Electric Co.*



The new standard 20-kw electronic induction heater makes an ideal partner for the HM 40 PV heat-treating machine. This heater can also be used alone for many selective heating applications. Whether you are annealing, brazing, soldering or hardening, it can help you do any or all these jobs faster, better and at lower cost.

Section 720–53, General Electric Co., Schenectady 5, N. Y.

Please send me a free copy of the following bulletins:

☐ for reference ☐ for immediate project

☐ GEA-5682, Type HM 40 PV Heat-treating Machine

☐ GEA-5594, New, Standard 20-kw Induction Heater

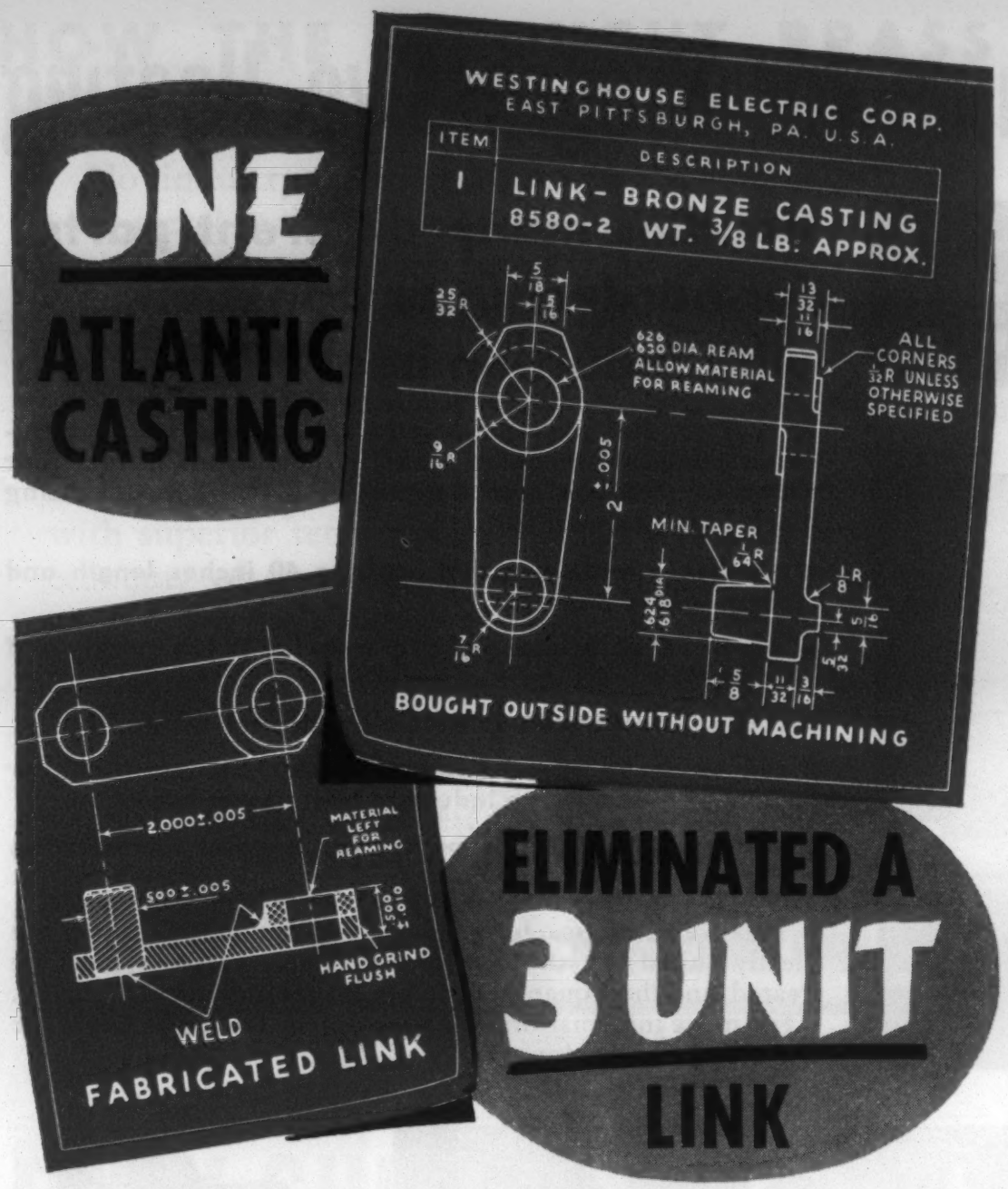
Name.....

Company.....

Street.....

City..... State.....

GENERAL ELECTRIC



FOR Westinghouse!

Westinghouse Electric Corp. recently required a part for use on oil circuit breakers. Their rough blueprint called for a link composed of three separate units which had not only to be machined, but welded together.

Atlantic's engineers suggested a design that resulted in a part cast in ONE PIECE from Atlantalloy #31 High Tensile Manganese Bronze . . . a dependable engineering material that is stronger than many steels. This one piece casting eliminated the involved machining, welding and finishing steps—and consequently afforded a substantial saving over former costs.

Write for a copy of "Quality Precision Castings for Industry" today. This booklet shows how the plaster mold process cuts production costs and includes specifications on Atlantic's alloys.

ATLANTIC CASTING and ENGINEERING CORP.
Established 1937
721 Bloomfield Avenue • Clifton, N. J. • PRescott 9-2450

Rolled Aluminum Bushings

continued from page 174

other grinding wheel makers. They are made from 16-gage 2SH14 aluminum in a variety of sizes ranging in length from ½ to 1 in. and in diameter from ⅝ to 1⅜ in.

Although the bushings are produced at the rate of more than 1 per sec, accuracy is held to within two-thousandths of an inch on the critical inside diameter. This is possible because aluminum is very nearly the perfect metal for machining with Federal-Mogul's rolled bushing process.

Four Production Steps

The process has four basic steps. First is the slitting operation, where rolls of aluminum strip are uncoiled through a machine that slits them to desired uniform widths. Next, the strips are passed through a cold rolling machine, which presses them to a thickness that does not vary more than one-thousandths of an inch. This machine also flutes one surface of the strip, or it makes diamond- or ball-shaped indentations, depending upon the customer's requirements.

Most impressive of all operations, however, is that performed on the punch presses. In a single powerful stroke that takes less than a second, it bites off a piece of the aluminum strip and rolls it into a perfect cylinder, with only a hairline seam indicating the point where the ends of the piece meet.

The final operation consists of chamfering, or paring the ends of the bushing to remove burrs or sharp edges.

Since the bushings produced by this method are precision products, no further machining is required by the grinding wheel makers. The flutes or other indentations on the outer surface bond tightly with the abrasive when the bushing is pressed into the wheel, and the smooth inner surface provides a perfect fit for the shaft. Thus, the grinding wheel is fitted with a hub that will remain true throughout its life.

● Atchison, Topeka & Santa Fe Railway has decided there really is uranium "in them thar hills". Announcement has been made of the formation of Haystack Mountain Development Co., a wholly owned Santa Fe subsidiary, to mine uranium discovered on Santa Fe property near Grants, N. M.

Design Dept.:

Have we taken a look at plastics lately?

J. B.

Properties like these certainly can be used to our advantage

Send for this information from Monsanto today!

Imp Camera Service provides this ingenious idea for picture taking. Camera molded of Lustrex styrene by Northwest Plastics, Inc. for Beaurline Industries, Inc. both of St. Paul, Minn.

Got the latest picture on Lustrex styrene plastic?

New developments in Lustrex styrene plastic made this new idea possible. First requirement was the idea for designing this ingenious camera service. Next was the material to bring it to life.

The "idea" here is to supply film already loaded in a camera so you can take pictures and have the use of the camera. Snap your pictures, put the camera in the mail (it comes in a handy self-mailer package), and you receive back twelve prints. The manufacturer reloads and starts the camera on another round of service.

Lustrex styrene fits into this picture from every angle—provides high strength with light weight, good dimensional stability, low-cost mass production economies through fast injection molding.

For your own product . . . or new idea . . . investigate Monsanto's big *family* of plastics. And, for expert materials engineering assistance, send your materials or design problem to THE MONSANTO TECHNICAL COUNCIL—a board of ten plastics technicians whose experience and knowledge blankets the plastics industry. Probably they can help you make an old product better . . . bring a new product to life.

Send for your free copy of Monsanto's booklet, "Idea Generators."

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CHEMICALS — PLASTICS
®

SERVING INDUSTRY
. . . WHICH SERVES MANKIND

MONSANTO CHEMICAL COMPANY, Plastics Division,
Room 2212, Springfield 2, Mass.

- ☐ Please send me your booklet, "Idea Generators."
- ☐ Please send me information on Monsanto's big family of plastics.
- ☐ Please send information about the Monsanto Technical Council and how they can help us.

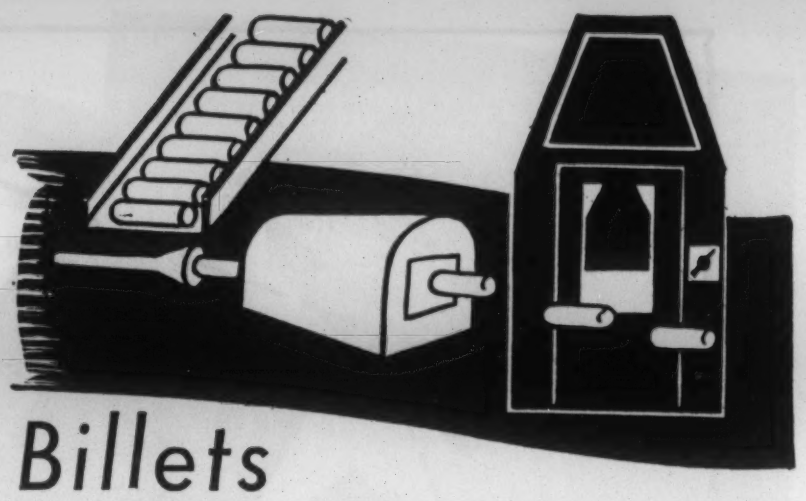
Name & Title _____

Company _____

Address _____

City, Zone, State _____

COLD STEEL



to Hot Billets

...IN 39 SECONDS

Ajax-Northrup heaters work so fast there's no time for oxidation or decarburization . . . no time for scale to form.

RESULT: Steel savings up to 20% . . . ten tons a day for one Ajax-Northrup equipped automobile manufacturer.

Typical production: 720 perfect pieces per hour.

Save steel in your forge shop. Write us today.

AJAX ELECTROTHERMIC CORPORATION

AJAX PARK • TRENTON 5, NEW JERSEY

AJAX NORTHRUP HEATING AND MELTING

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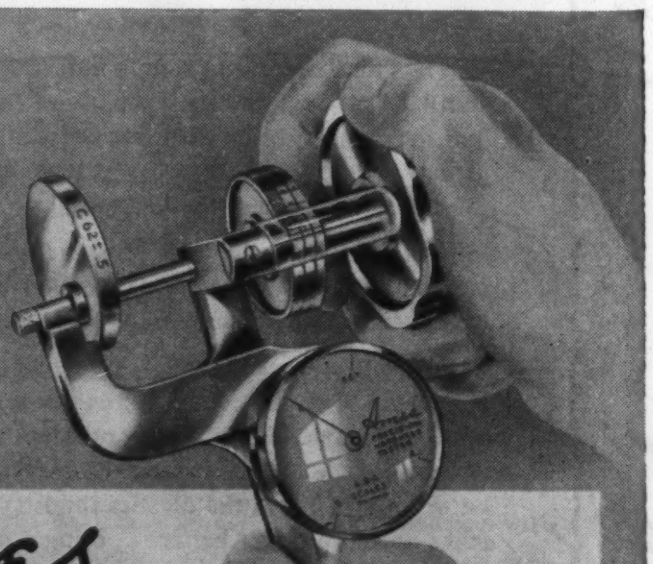
AJAX ELECTRO METALLURGICAL CORP. • AJAX ELECTRIC CORP.
AJAX ENGINEERING CORP. • AJAX ELECTRIC FURNACE CORP.

141-S

For quick, accurate, on-the-spot hardness testing, reading directly in the Rockwell scales.



Ames PORTABLE HARDNESS TESTER

Flat and round bars, sheets, tubing and wire are tested on the spot without cutting off specimens. Punches, dies, cutters, saws and odd-shaped pieces are tested before and after heat treating. Used by metallurgists, inspectors and heat-treaters. Sizes for work 1" to 6" round and flat. Send for illustrated circular.

Complete with two penetrators, anvils, test blocks, case and chart.

AMES PRECISION MACHINE WORKS

Makers of Precision Bench Lathes & Milling Machines

WALTHAM 54, MASSACHUSETTS

News Digest

continued from page 13

been released by the Office of Technical Services of the U. S. Dept. of Commerce, Washington 25, D. C.

Although much of NACA's research material may appear useful only to the Nation's plane and engine builders, nevertheless the agency has furnished answers to fundamental problems affecting all kinds of industries. For example, investigations of materials, alloys and fuels for possible use in gas turbines and rotary compressors may provide valuable information to non-aviation manufacturers. The principles affecting the aeronautical gas turbine and rotary compressor may also affect the turbines and compressors that are found in central power stations and pipeline pumping stations.

In all, 310 reports are listed from federal, foreign and other non-confidential sources; most of them not previously publicized. Various technical fields are covered, including chemical and allied products; electrical machinery, equipment and supplies; fuels and lubricants; instruments; machinery; metals and metal products; minerals and mineral products; and rubber and rubber products.

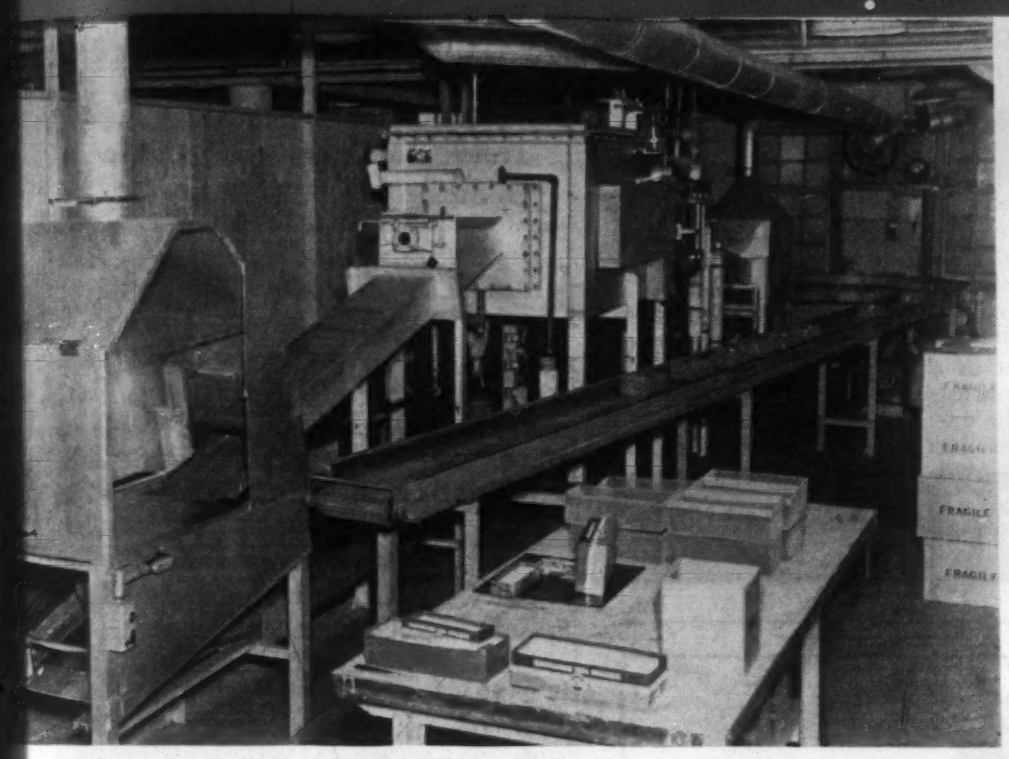
● The General Electric Co. reports that 60¢ out of every dollar it received from the Air Force for jet planes in the last year went to other companies. More than 4000 suppliers furnished parts, materials and services for the J-47 engine. Of these, over 82% were small businesses with less than 500 employees.

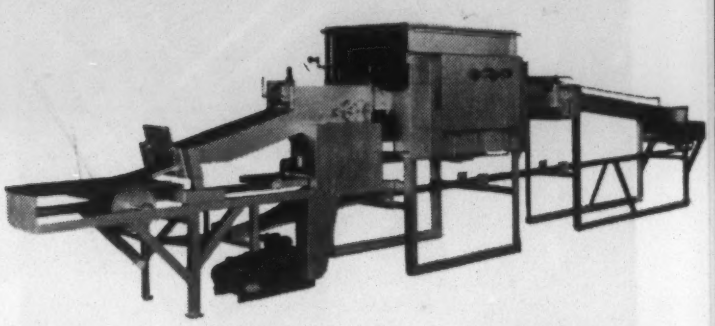
NACA Research Abstracts Cover Materials Problems

Several of the technical notes and research abstracts published last month by the National Advisory Committee for Aeronautics, Washington 25, D. C., are of interest to materials engineers. These papers include:

"Rupture Properties of Low-Carbon N-155 Type Alloys Made With a Columbium Tantalum Ferro-

At various RCA plants 26 "CERTAIN CURTAIN" Furnaces





Famed "humpback" design

For its critical controlled-atmosphere heat treating, RCA makes wide use of the inclined-hood furnace developed by C. I. Hayes, Inc., out of its experience as the oldest maker of electric atmosphere furnaces. Shown at left is an installation at the Harrison, N. J., RCA plant.

RADIO CORPORATION of AMERICA RECEIVES IMPORTANT BENEFITS FROM HAYES INCLINED-HOOD CONVEYOR FURNACES

"Humpback" saves better than 90% of atmosphere cost

Used for bright annealing, grid firing, degassifying of radio and TV tube parts of stainless steel and nickel, Hayes furnaces at RCA are delivering both high volume and high quality. Components are treated in hydrogen atmosphere with tremendous savings due to humpback design. Furnace shown above consumes about 100 CFH of hydrogen, but without inclined-hood feature, would require over 1000 CFH. We consider RCA one of the finest examples of how a Hayes user can successfully maintain the highest standard of QUALITY in critical heat-treating operations, and at the same time enjoy outstanding ECONOMY.

CALL OUR NEAREST REPRESENTATIVE — REQUEST LATEST CATALOG

C. I. HAYES INC. 80 BAKER ST., PROVIDENCE, R. I.

Manufacturers of Electric Furnaces Since 1905

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W. G. FRAED
416 N. State St.
Chicago, Ill.

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202 Forest Ave.
Royal Oak, Mich.

BOLAN INDUSTRIAL SALES
Union National Bank Bldg.
Houston, Texas

L. WAGNER
112 Loumar Avenue
San Jose 12, Calif.

L. J. EDWARDS
New England Rep.
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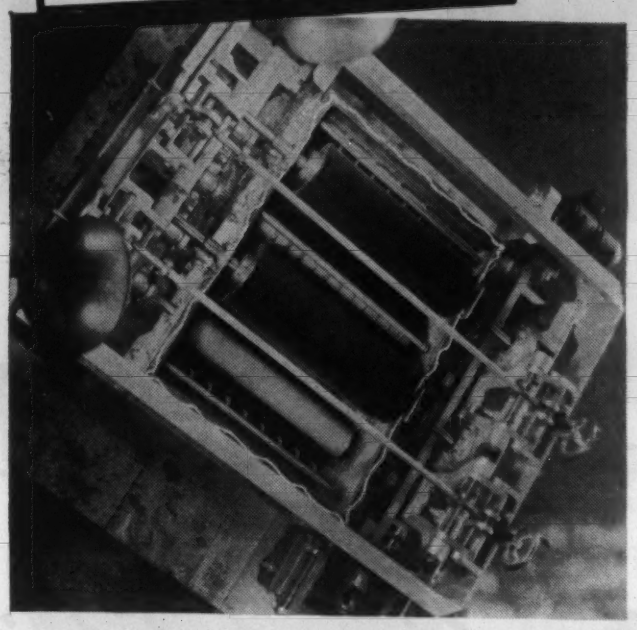
T. C. JARRETT
3501 Vallejo St.
Denver 11, Colorado

ROCKWELL BRUSHING MACHINE

Brushes—Cleans Metal Surfaces Continuously



SAVES TIME AND LABOR

- *Brushing strip after pickling*
- *Removing dirt and grease before painting or finishing*
- *Removing burrs*

The Rockwell Brushing Machine—which may be incorporated into a continuous process—brushes, scrubs and spray washes the metal automatically at a controlled production rate—leaving the surface truly clean.

Let us show you how to cut your brushing costs by speeding up the operation and improving the product quality.

W. S. ROCKWELL COMPANY
208 ELIOT STREET • FAIRFIELD, CONN.

Harper

Electric

MUFFLE FURNACES

Operating Temperature 2350°F.

Maximum Temperature 2500°F.

Model HOU-9715-M-26 for annealing fused quartz parts. Photo Courtesy P. R. Mallory Co., Inc.

● Harper Electric Muffle Furnaces designed for heating materials in an oxidizing atmosphere fill the need for many general operations in research laboratories, tool rooms and production work. Uses include general heating of metals and alloys, annealing processes, drying of precipitates, ash determinations, ignitions, enameling and ceramic firing.

Counter-balanced recessed sliding doors facilitate rapid charging and discharging during special processes. Properly located elements placed over and under the muffle assure uniform temperature throughout the heating chamber. Temperature uniformity is further assured by elimination of the usual cold vestibule by means of the unique recessed door design.

Available in several standard sizes. Write for bulletin 346.

Furnaces for higher temperatures, more rapid heating and with atmosphere controls also available. Address inquiries to Dept. 6.

HARPER ELECTRIC FURNACE CORPORATION
39 RIVER STREET, BUFFALO 2, NEW YORK

News Digest

Alloy," by J. W. Freeman, E. E. Reynolds and A. E. White, University of Michigan, Oct. 1951, 11 pp., diagrams, 2 tables (NACA TN 2469).

"Fundamental Effects of Cold-Working on Creep Properties of Low-Carbon N-155 Alloy," by D. N. Frey, J. W. Freeman and A. E. White, University of Michigan, Oct. 1951, 45 pp. diagrams, photos (NACA TN 2472).

"Theory of Thin-Walled Rods (O Teorii Tonkostennykh Sterzhnei)," by A. L. Goldenveizer, Oct. 1951. 53 pp. (NACA TM 1322. Trans. from *Prikladnaya Matematika i Mekhanika,* V. 13, Nov.-Dec. 1949, pp. 561-596).

"Effects of Some Solution Treatments Followed by an Aging Treatment on the Life of Small Cast Gas-Turbine Blades of a Cobalt-Chromium-Base Alloy II—Effect of Selected Combinations of Soaking Time, Temperature and Cooling Rate," by C. A. Hoffman and C. F. Robards, Oct. 1951, 19 pp., diagrams, photos, 4 tables (NACA TN 2513).

"Investigation of Influence of Chemical Composition on Forged Modified Low-Carbon N-155 Alloys in Solution-Treated and Aged Condition as Related to Rupture Properties at 1200 F," by E. E. Reynolds, J. W. Freeman and A. E. White, University of Michigan, Sept. 1951, 111 pp., diagrams, photos, 11 tables (NACA TN 2449).

"Resolution of Annealing Experiments for the Study of Nonequilibrium States," by Philip Schwed, Sept. 1951, 15 pp., diagrams (NACA RM E51G24).

"Forest Products Research Laboratory (Great Britain) Investigations into Glues and Gluing. Progress Report 62—May 1951. The Comparative Durability of Plywood Glues in England and in Nigeria. (Series IV)," by J. F. S. Carruthers and A. M. Thomas. 11 pp., photos, 3 tables (Forest Products Research Lab.).

● A bibliography of the German chemical, metallurgical and process industries is available from the Office of Technical Services, Dept. of Com-

(Continued on page 183)

News Digest

merce, Washington 25, D. C. Post-war conditions are covered by over 2000 document references.

News of Engineers

E. Brewster Crawford, formerly vice president and general manager of Auburn Button Works, Inc., has been named president of the company.

At a recent meeting of the board of directors of Lincoln Electric Co., *William Irrgang* was elected executive vice president.

Adger S. Johnson has been appointed president of National Carbon Co., division of Union Carbide and Carbon Corp., according to a recent company announcement. Mr. Johnson has been vice president and general manager of the company since May 1950.

Associated Plastic Companies, Inc. has announced the appointment of *William C. P. Zabel* as new operating head of the firm with the title of executive vice president. *Paul Young,* formerly manager of the Plastic Div. of the Central Die Casting and Manufacturing Co., has been appointed general manager of the Midland Plant, according to another recent company release.

Three promotions have been announced in the Plant Engineering Dept. of the Willard Storage Battery Co.'s Cleveland plant: *Paul G. Gleason* has been named manager of plant engineering; *Fred R. Kerns,* equipment engineer; and *V. G. Korfhage,* plant engineer.

Frank A. Votta, Jr. has been elected chief engineer of the Hunter Spring Co. Associated with the company since 1941, Mr. Votta has been engineer in charge of design in the company's Neg'ator Div. for the last 2½ years.

The appointment of *William N. Noble* to the position of assistant to the president has been announced by Ferro Corp. Promotion of *J. H. Ginther* to assistant to the vice president has also been announced by the company.

Benjamin F. Fairless, president of the United States Steel Corp., has been selected to receive this year's Gold Medal of Merit award, given annually by the Wharton School Alumni Society of the University of Pennsylvania. The award, which recognizes outstanding leadership in American business, was formally presented on Nov. 12.

The appointment of *Swan Bergstrom* as director of the Metalworking Equipment Div. of NPA was recently announced by the Department of Commerce. Mr. Berg-

ITS BIMETAL SWITCH IS AUTOMATIC

The Tune-O-Matic, Manufactured by Electro-Voice, Incorporated, is an electronic device which automatically amplifies your TV signal. It improves reception in low signal fringe locations and in prime service where an indoor antenna is used. Chace Thermostatic Bimetal plays a vital part, providing a reliable and completely automatic switch which operates in any position, with long life and freedom from buzzing. As the Tune-O-Matic is installed out of sight, often upside down in the cabinet, dependability is mandatory, and the switch must operate without being affected by gravity.

The Tune-O-Matic is plugged into the 105-120 AC outlet and the receiver cord into the booster. Note that the thermostatic bimetal element is generally T-shaped, and that the free upper end of the inner part of the stem at "A" carries the moving contact to the booster circuit. When the set is turned on, the current passes from the lead-in connection at "B" around the narrow outer part of the stem to "C" and so into the receiver receptacle. The resistance of the thermostatic bimetal generates heat under this load, causing it to deflect away from the high resistivity side of the bimetal. Hence, point "A," normally in approximate position shown by dotted lines, deflects down, closing the contacts and completing the circuit to the booster in 2 or 3 seconds. When the set is turned off, the bimetal cools and returns to its original position, breaking the circuit automatically.

Electro-Voice consulted Chace Applications Engineers, specified one of the 29 types available and fabricate from strip. Chace also furnishes random lengths and fabricates and assembles complete elements to customer specifications. Our engineers are ready to assist you in designing your own actuating device and our 64-page reference on thermostatic bimetal is yours for the asking.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

Wherever it's

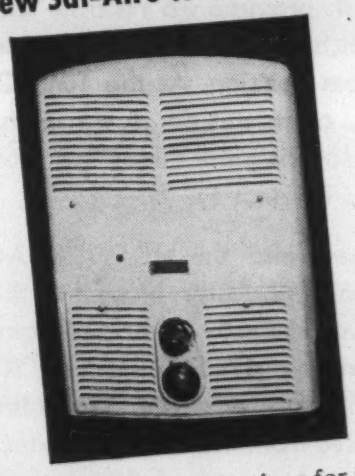
HOT

specify

Sicon

NEW IMPROVED SILICONE-BASE HEAT-RESISTANT FINISH

Protects Stewart Warner's New Saf-Aire Wall Furnace



Quality finish specifications for this heating unit called for a coating that would stand 500° and still retain its color and gloss—a temperature far above that incurred in normal operation. Ordinary heat resistant coatings failed. SICON *Ivory* and SICON *Beige* worked perfectly...just as SICON has solved so many other finish problems. *Write for dynamic proof of SICON'S amazing stability under heat! New Brochure now ready.*

Sicon

Silicone-Base Finish is manufactured exclusively by

MIDLAND INDUSTRIAL FINISHES CO.

Waukegan, Illinois

ENAMELS · SYNTHETICS

LACQUERS · VARNISHES

News Digest

strom is currently on leave as vice president and director of the Cincinnati Milling Machine Co.

W. H. Bruckner, research associate professor of metallurgical engineering, University of Illinois, received the 1951 Lincoln Gold Medal at the American Welding Society's annual meeting in Detroit. This award is made annually by the Society to the author of the paper judged to be the greatest contribution to the advancement and use of welding for the year.

Dr. *Thomas R. Steadman* has joined the Petrochemicals Research Dept. of National Research Corp.

Battelle Memorial Institute has announced the following promotions and elections: *Lloyd R. Jackson* has been named assistant director of the Institute and will handle research coordination; Dr. *Horace J. Grover* has been promoted to supervisor of research on fatigue and structural analysis; *Arthur D. Schwope* has been promoted to supervisor of research in mechanical metallurgy; and *Henry A. Saller* has been advanced to the position of supervisor of research on special metallurgical materials. *Charles F. Lucks* will supervise the Instrument Div.

The following new officers were elected at a recent board meeting of the Twin Disc Clutch Co.: *G. L. Shuman,* vice president of finance and secretary; *R. G. DeLong,* vice president—Hydraulic Div.; and *W. F. Shurts,* director of engineering.

Owen R. Rice, metallurgical engineer, has been named vice president and manager of the Freyn Engineering Dept., Engineering and Construction Div., Koppers Co., Inc. Mr. Rice will have general supervision and coordination of the Division's activities in the projecting, sale, erection, operation and management of steel making facilities and other metallurgical processes or equipment.

Edward B. Noel, development engineer at General Electric Co., received the second annual journal award at the national convention of the Photographic Society. Mr. Noel was presented a scroll for the most significant contribution in the technical or scientific fields for 1950. General Electric Co. has also announced the following appointments within its organization: *Clayton P. Fisher, Jr.* has been named manager of materials and purchasing for the company's Major Appliance Div.; *Carl H. Rinne* has been elected general manager of the company's Specialty Transformer and Ballast Dept. at Fort Wayne to succeed *William C. Wichman,* now general manager of the organization's Component Products Div.; *F. Charles Ruling* has been appointed manager of the Atlantic district of G-E's Apparatus Sales Div.; and *James J. Fitzgibbon* has succeeded to Mr. Ruling's

Brand New!

GRC SMALL DIE CAST TUBULAR RIVETS

BY THE MAKERS OF POPULAR GRC WING NUTS

PROMPT DELIVERY on standard sizes: 1/16" to 9/64" dia.; up to 5/16" lgth. Specials to order.

● non-ferrous zinc alloy ● rustproof and corrosion resistant ● die cast (not headed!) to closer tolerances with more uniform heads for greater riveting efficiency ● recommended where shear and tensile strength of steel is not required ● in all commercial finishes at substantial savings ● usable unfinished for greater economies.

Write for bulletin, samples, prices.

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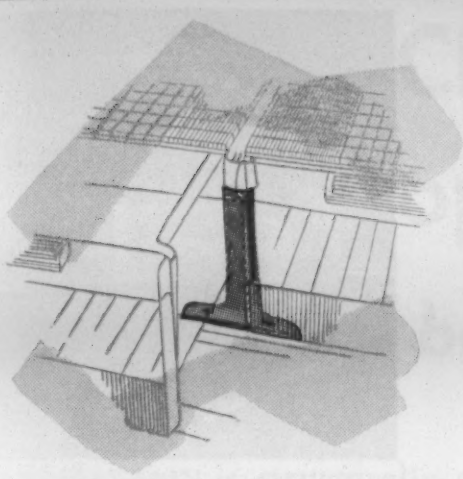
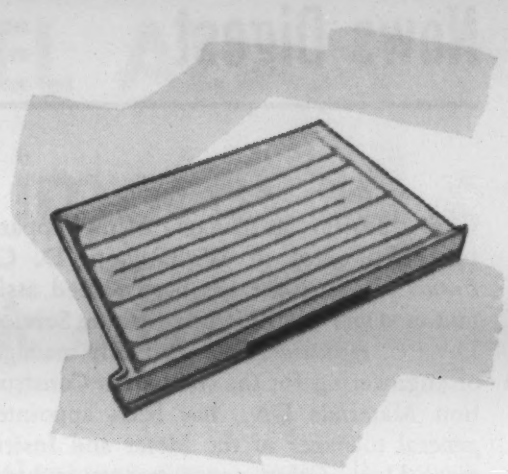
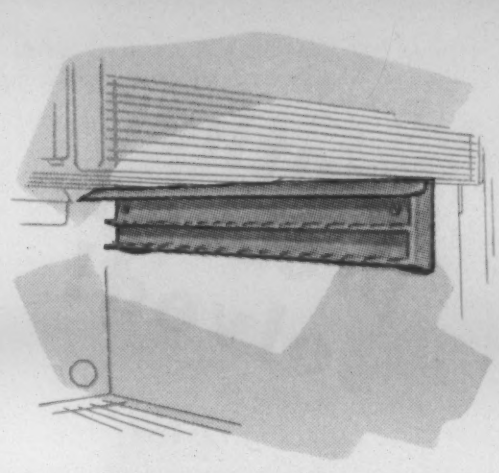
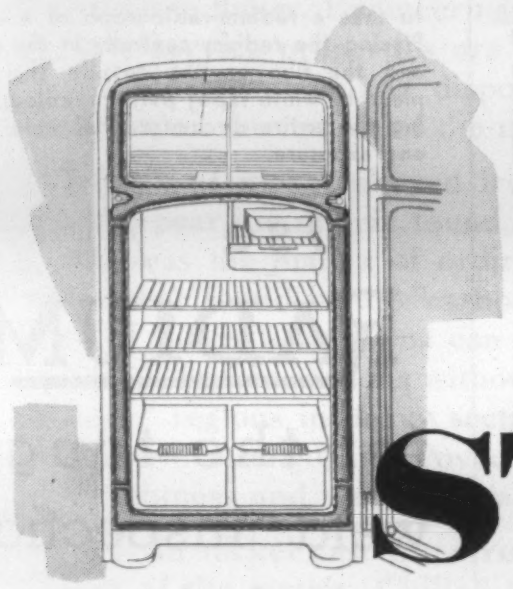


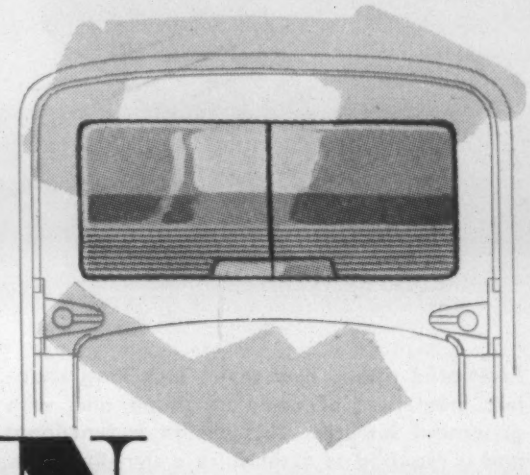






NOW AVAILABLE

STYRON 475



Admiral refrigerator parts shown are economically produced from Styron 475.

High impact formulation that answers the immediate need of Industrial Designers

Other Admiral Refrigerator Parts Are Made from 666, Another Formulation of Styron

Formulation 666 was used in making the following parts: upper inner door panel; hydrator pans; hydrator shelf; refrigerator tray; dairy drawer; freezer tray; name plates, knobs, etc.

Today Styron 475 is used by Admiral and other refrigerator manufacturers as a material outperforming all others in certain capacities. This was also true even when other engineering materials were in plentiful supply. Styron 475 is chosen by this great appliance corporation for its shock resistance, light weight, dimensional stability, resistance to moisture, moldability and design freedom.

Whether *you* are designing intricate functional parts or decorative products, versatile Styron 475 may be the material that points the way to improved production at lower cost. Investigate how Dow's strict quality control, consistent and uniform coloring and excellent technical services can help you produce component parts or complete products cheaper, better and faster.

Styron brand plastics, remember, are available in a wide range of *quality-controlled* colors and formulations, of which Styron 475 is one. Dow's Plastics Technical Service is equipped to help you determine the applicability of Styron to your manufacturing operation.

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Plastics Department—PL-89
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Write Today!

The Styron label is the hallmark of quality in plastics goods.

STYRON *brand plastics*

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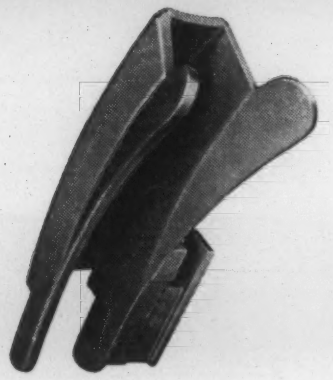
another problem solved!



Illustrated above is a seven inch long stainless steel part of complex shape and with generated surfaces. This design is functional and is required to accomplish a specific result. The hood is of 1/8" stock and has a heavy side bracket.

The shape is such that it does not lend itself to machining. It is not a part that can readily be formed by stamping and welding without running into distortion and loss of control of dimensions.

For lowest cost and uniformity of parts Precision Investment Casting was the only practical way to make this piece both as to unit cost and tooling expense. This is but one example of the many places where Precision Investment Castings are fitting into the tooling and manufacturing plans of progressive designers and engineers.

We want to help you eliminate problem parts. Send prints for quotations without obligation to—

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News Digest

former position as manager of the Apparatus Sales office in Washington, D. C.; *Francis K. McCune* has been named assistant manager of G-E's Engineering Services Div.; *C. Howard Black*, formerly manager of engineering for the company's Construction Materials Div., has been appointed general manager of the Meter and Instrument Dept. Other appointments include: *Donald F. Warner* has been named assistant to the manager of engineering for the Turbine Dept.; *J. Herbert Behm* has been named staff assistant to the manager of engineering of the Small Apparatus Div.; and *Arthur F. Vinson* has been named assistant manager of the company's Manufacturing Services Div. Two vice presidents have also been elected at G-E: *John W. Belanger* has been elected a vice president and general manager of the organization's newly-created Defense Products Div.; and *Nicholas M. DuChemin*, in addition to being named a vice president, was placed in charge of the company's Manufacturing Services Div.

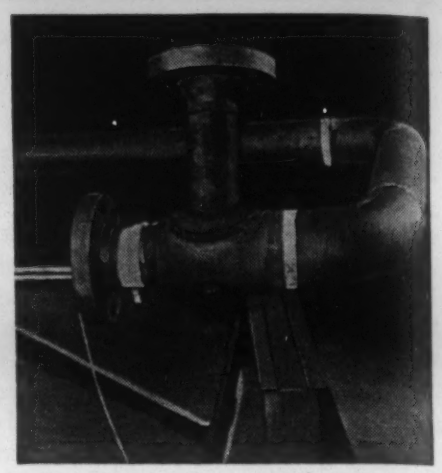
Malvern J. Hiler has been appointed president of The Commonwealth Engineering Co., according to a recent company announcement. For the past three years, Mr. Hiler has served the company in the capacity of executive vice president.

Olin Industries, Inc. has announced the appointments of *Richard F. Adams* and *Robert F. Hartman* to the company's Metal Products Dept. of the Research and Development Div. *George Dillender, Glen Schlueter* and *Harold Wilken* were also given new positions by Olin in the Explosives Dept. of the division.

Dr. *Carl Wagner*, visiting professor of metallurgy, Massachusetts Institute of Technology, received the first Palladium Metal Award of the Electrochemical Society. Presentation was made to Dr. Wagner for outstanding achievements in the study of corrosion of metals and its control.

Worthington Pump and Machinery Corp. has named seven plant executives to new posts, according to a recent announcement. Manufacturing executives in new posts include: *George P. Passmore*, assistant to the vice president in charge of manufacturing at the Harrison plant; *A. M. Tullo*, works manager of the company's Wellsville, N. Y. plant; *John Burlick*, assistant to the works manager at the Harrison plant; and *Max A. Heyman*, assistant to the works manager at the Harrison plant in charge of production control activities. Engineering executives in new posts are: *W. D. Sizer*, manager of Regional Engineering and Service Dept.; *George F. Habach*, executive engineer at the Harrison plant; and *Everett Schmachtenberg*, chief engineer of the Centrifugal Engineering Div. *H. V. Rasmussen* has been appointed executive engineer at the Wellsville plant.

Hooker Electrochemical Co. has announced the appointment of *Thomas E.*



THIS PHOTO shows radium being used to take a radium-radiograph of a weld. Placing the radium centrally in the pipe and the film on the outside (held in place by white tape) permits radiographing the entire circumferential weld with one exposure.

Use RADIUM for the tough weld inspection jobs

because radium-radiographing equipment is

1. **Portable**
2. **Easily handled**
3. **No training needed to operate**
4. **Economical**

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For the same reasons that radium-radiography has won nearly universal acceptance in steel foundries throughout the country, it is becoming the preferred means of inspection in welding shops.

No capital investment is required to have radium-radiography available for the inspection of welds because the equipment may be rented or leased with economy.

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NICKEL ALLOY IRONS develop improved properties

plus all the basic advantages of plain cast iron

PLAIN GRAY IRON is, structurally, a steel matrix containing graphite flakes. Engineering, physical, processing and service properties are wholly dependent upon the character and disposition of these flakes, and upon the nature of the matrix.

The matrix of nickel alloyed irons closely resembles the pearlitic matrix found in high carbon steels, whereas the matrix of ordinary plain iron resembles that found in low carbon steels. Compositions of nickel alloy irons can be adjusted to reduce "chill" in thin sections without risk of forming "spongy" regions in heavy sections. This promotes uniform strength, improved machinability, pressure tightness and wear resistance.

Hardness in nickel cast irons results from improvement of the matrix. Chilled areas and hard carbides, which impair machinability, are obviated. Nickel improves response to heat treating. In fact, use of nickel alone or with other alloying elements plays an important part in meeting a variety of requirements.

Accordingly . . . nickel alloyed irons permit production of castings with high levels of the following properties:

Strength

Tensile and transverse strengths of castings are greatly increased by the addition of nickel to cast irons of properly adjusted base mixture. The ratio of compressive strength to tensile strength is retained. Greater uniformity of strength in thick and thin sections is achieved.

Elasticity

The elastic modulus increases with strength. In this respect nickel-containing irons of the high strength type possess good stiffness and do not deform permanently under loads that would be damaging to irons of lower elastic modulus.

Damping Capacity

The damping capacity inherent in gray cast iron is not impaired by the presence of nickel.

Wear Resistance

The uniformly pearlitic matrix of nickel cast irons appreciably improves wear resistance. The uniformly fine graphite flake distribution, achieved in suitably processed irons *without formation of a poor wearing dendritic condition,* affords optimum resistance to wear and galling.

Pressure Tightness

Characterized by dense grain structure and fine dispersion of graphite throughout, nickel alloy irons are close-grained and offer an extraordinary degree of pressure tightness under high hydrostatic pressures, without sacrificing machinability.

Applications

Heavy machinery frames and *beds* are typical of cast parts that benefit from the rigidity and good damping capacity of nickel cast irons. *Cylinder* and *pump liners, gears, dies, machine tool ways, saddles* and *tables* exemplify parts produced in nickel irons to assure greatly increased strength and wear resistance. And nickel alloyed iron is used for *heavy duty brake drums* to resist heat checking, thermal shock, wear and galling. The nickel cast irons are readily heat treated, and respond particularly well to flame and induction hardening.

At the present time, the bulk of the nickel produced is being diverted to defense. Through application to the appropriate authorities, nickel is obtainable for the production of engineering nickel cast irons for many end uses in defense and defense supporting industries.

The International Nickel Company, Inc.
Dept. MM, 67 Wall St., New York 5, N. Y.

Please send me booklet entitled, "Guide to the Selection of Engineering Cast Irons."

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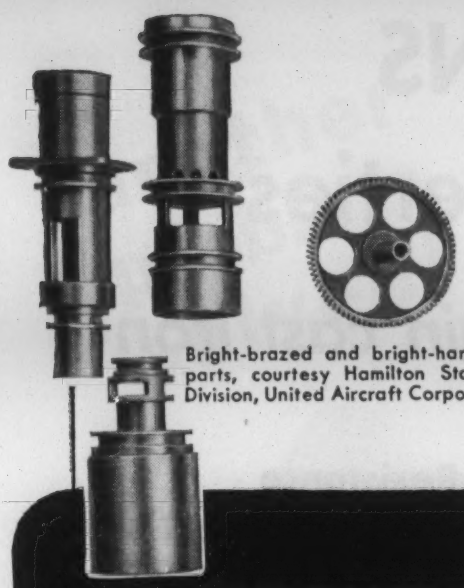

Bright-brazed and bright-hardened parts, courtesy Hamilton Standard Division, United Aircraft Corporation.

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OF STAINLESS STEEL AND NON-FERROUS METALS WITH A

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Now, parts made of stainless can be BRIGHT-ANNEALED, BRIGHT-HARDENED or BRIGHT-BRAZED without oxidation, on a continuous production basis. They come from the controlled-atmosphere conveyor furnace scale-free, bright and clean.

No pickling, sand blasting or tumbling required. These costly operations are eliminated, so your parts retain their sharp design and edges. A special Sargeant & Wilbur alloy for bright-brazing makes the joint practically invisible because it resists dulling and matches the metal color perfectly. Steel and non-ferrous metal parts are brazed in the same operation with excellent results.

Bright ANNEALING HARDENING AND BRAZING STAINLESS STEEL

Your samples processed FREE. To see your products bright-brazed, send samples and specifications.

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News Digest

Moffitt to the position of works manager of the Tacoma, Wash. plant. Mr. Moffitt succeeds *John D. Rue,* who has retired. Another promotion at the Tacoma plant was *George Gentes* to plant engineer, succeeding *Howard D. Norris,* retired.

Walter H. Salzenberg has been appointed assistant general manager of the du Pont Co.'s Grasselli Chemicals Dept., according to a recent release. Mr. Salzenberg succeeds *Clark W. Davis,* who will assume the duties of general manager of the Department, following the retirement of *Emmet C. Thompson.*

Election of *John F. Ansink* as vice president of the Round Chain & Manufacturing Co. has been announced by the company's president. Mr. Ansink had been general manager of the company since its formation two years ago.

Robert M. Lloyd has been elected vice president—Raw Materials of United States Steel Co.

Johan A. Muller has joined the Lewis Welding & Engineering Corp. as head of a newly formed development department having to do with the further development of plastic injection molding equipment.

Dr. *Mac Hansen,* assistant chairman of the Metals Research Dept. at Armour Research Foundation of Illinois Institute of Technology, has been promoted to chairman of the Department. Dr. Hansen succeeds Dr. *Carl Swartz,* who ha . been named metallurgical consultant.

Combining of the electrical and mechanical power departments of Allis-Chalmers Manufacturing Co. into a power department under the management of *R. M. Casper* has been announced by the company. Mr. Casper had been manager of the Electrical Dept. since 1949.

Don Balfour, former works manager at the Nashville Div. of Consolidated Vultee Aircraft Corp. during World War II, and more recently plant superintendent for AVCO, has assumed the position of factory manager at Texas Engineering and Manufacturing Co., Inc. The promotion of *Harold B. Ridgley* to assistant superintendent in charge of all tool manufacturing and engineering, and of *Paris F. Young* as assistant superintendent of Machine Shop and Spar Milling and Finishing has also been announced.

W. R. Meikle has joined the National Radiator Co. and has been placed in charge of heavy steel defense production for the company's steel boiler plant at Middletown, Pa.

James L. Vaughan has been appointed director of the Process Engineering Dept. at National Research Corp.

Harnischfeger Corporation has announced the death of *Henry H. Erkelenz,*

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on Zinc

replacing Chromium, Cadmium or Nickel plate, offering Corrosion-Resistant, Brilliant Finish at Lowest Cost

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- ✓ Auto body parts
- ✓ Bathroom hardware
- ✓ Aircraft metal parts
- ✓ Wire goods
- ✓ Refrigerator shelves
- ✓ Radio speakers, chassis, shields
- ✓ Television parts
- ✓ Electrical parts
- ✓ Air conditioning fans, guards, etc.
- ✓ Bolts, nuts, washers, rivets
- ✓ Builders' hardware
- ✓ Outdoor metal articles (fences, trailers, etc.)

also

- ✓ Protective finishes

covered by Federal Specifications for Army Signal Corps, Army Ordnance, Army and Navy Aeronautical.

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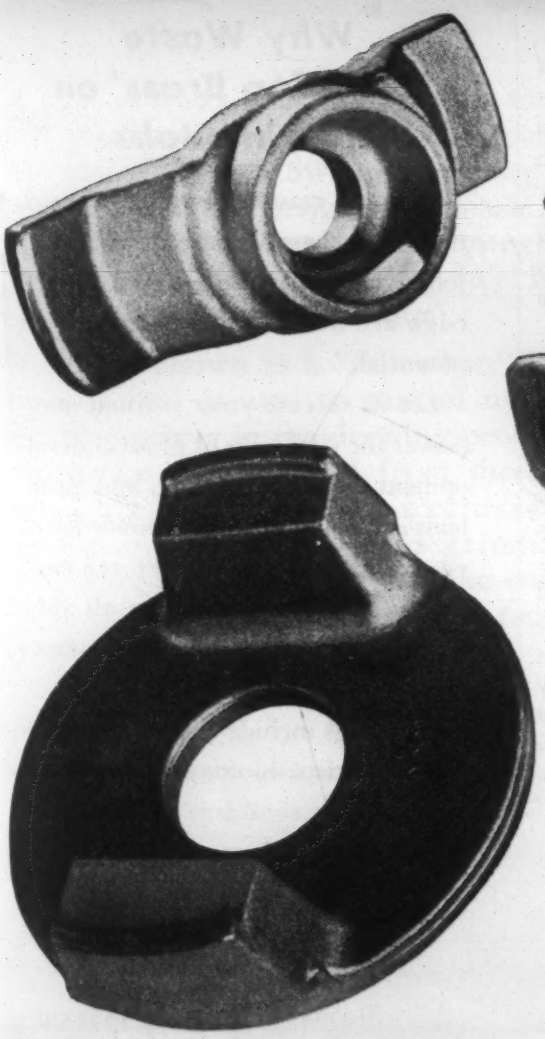
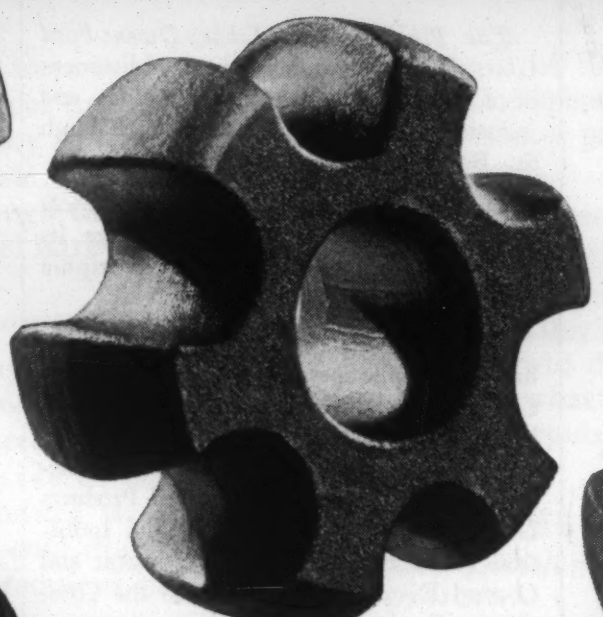
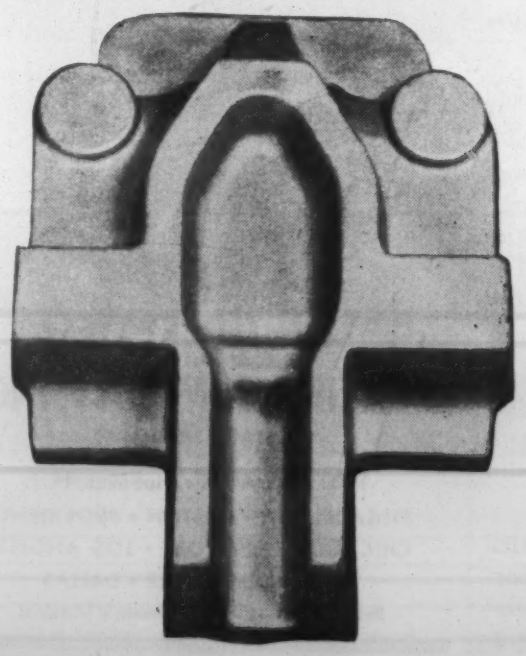
BETHLEHEM DROP FORGINGS







We've made millions of them through the years—drop forgings for such widely differing fields as petroleum, mining, automotive, electrical, aviation, and many others. We hope and expect to make other millions of these high-quality forgings in years to come.

Whenever your specifications call for a closed-die job, remember the name Bethlehem. For decades this name has been closely identified with good drop, press, and upsetter forgings.

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Send $1.00 for Trial Test Kit!

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Please send me your trial test kit of Armstrong adhesives with suggestions for new uses. My dollar is enclosed.

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News Digest

retired vice president and member of the executive committee of the corporation.

The International Nickel Co., Inc. has announced the death of *Calvin Sterling*, 49. Mr. Sterling was head of the company's Analytical Section of the Research Laboratory.

News of Companies

The Plaskon Div., Libbey-Owens-Ford Glass Co. has announced the establishment of a New England office for glues and industrial resins, to be located at 10 High St., Boston.

Conoflow Corp. has announced the opening of an auxiliary plant to enlarge its manufacturing facilities in the Philadelphia area.

Formation of six new operating divisions has been announced by *General Electric Co.* The new divisions include the Turbine Div. and the Motor and Generator Div., both with headquarters at Schenectady; Transformer and Allied Products Div., Pittsfield; Measurements and Industrial Products Div., Lynn; Switchgear and Control Div., Philadelphia; and the Component Products Div., with headquarters at Fort Wayne. Together with the recently announced Defense Products Div., the new six include the majority of the departments which constituted the former Large Apparatus and Small Apparatus Division.

The United States Rubber Co. has announced that it has acquired the assets of the *Chicago Die Mold Manufacuring Co.* The business will be operated as *Chicago Die Mold Div., U. S. Rubber Co.*

Copperweld Steel Co. has purchased all the outstanding stock of *Flexo Wire Co., Inc.* Flexo will be operated as a wholly owned subsidiary of Copperweld.

Upressit Products Corp. recently marked its 38th anniversary.

According to a recent announcement from *National Research Corp.*, the company will build additional plant facilities on Charlemont St. in Newton, Mass. The new plant will be occupied by the Equipment Div.

A Latin American office has been opened in Mexico City by *Arthur D. Little, Inc.* The new office will serve as a convenience to the company's growing number of Latin American clients.

In a move aimed at alleviating the critical shortage of sulfur and its most important compound, sulfuric acid, *Shell Chemical Corp.* will add to its Houston opera-

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There's no reason for tying up engineers and chemists on routine testing jobs where their talents and knowledge are not utilized at maximum potential.

Let us release your trained manpower for vital tasks of product development, trouble-shooting, and problems involving intimate knowledge of your own operations. We are eminently capable of handling all your routine testing which normally flows through your laboratories.

Our staffs include engineers, chemists, physicists, biologists, and specially trained technicians. They have at their disposal extensive scientific equipment including such facilities as a radioisotope laboratory and a spectro-chemical laboratory.

Let's discuss the matter at your convenience. We are sure you will find it more economical, as well as more efficient, to use our services for your routine testing.

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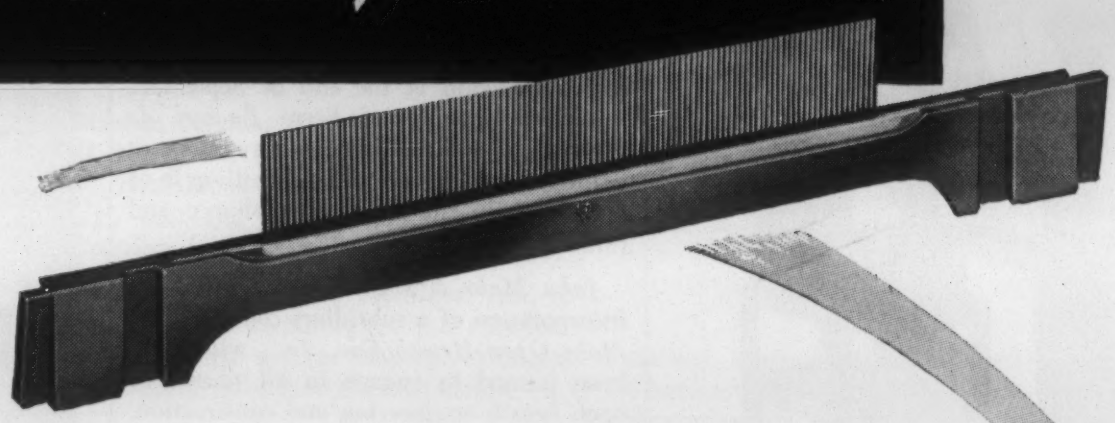
TEXTILE MACHINE PART LASTS THREE TIMES LONGER... *when made of* *Republic Alloy Steel*



NOT ALWAYS is it possible to improve a product and at the same time cut its cost. But the Warner & Swasey Company did just that by changing design of a textile machine part—a change made practical through the use of Republic Cold Drawn Alloy Steel Bars with Carbon Correction Annealing.

The part, known as a "faller bar," looks like a comb, and is used to control nylon, rayon and wool fibres in the drawing process. When the design was changed from three-piece to one-piece construction—exclusive of the needles—welding and weld grinding were eliminated. Furthermore, the fine cold drawn finish free from decarburization required no surface grinding.

New high strength of the part permitted an increase in machine speed. Wear was reduced—bending and twisting practically eliminated. Rejects were reduced.

And—probably of greatest importance—life of the part was increased more than 200%.

Maybe the high strength, toughness and hardenability of Republic Alloy Steels combined with the advantages of cold drawing and carbon correction are just what your product needs. Why not invite a Republic metallurgist in to talk it over?

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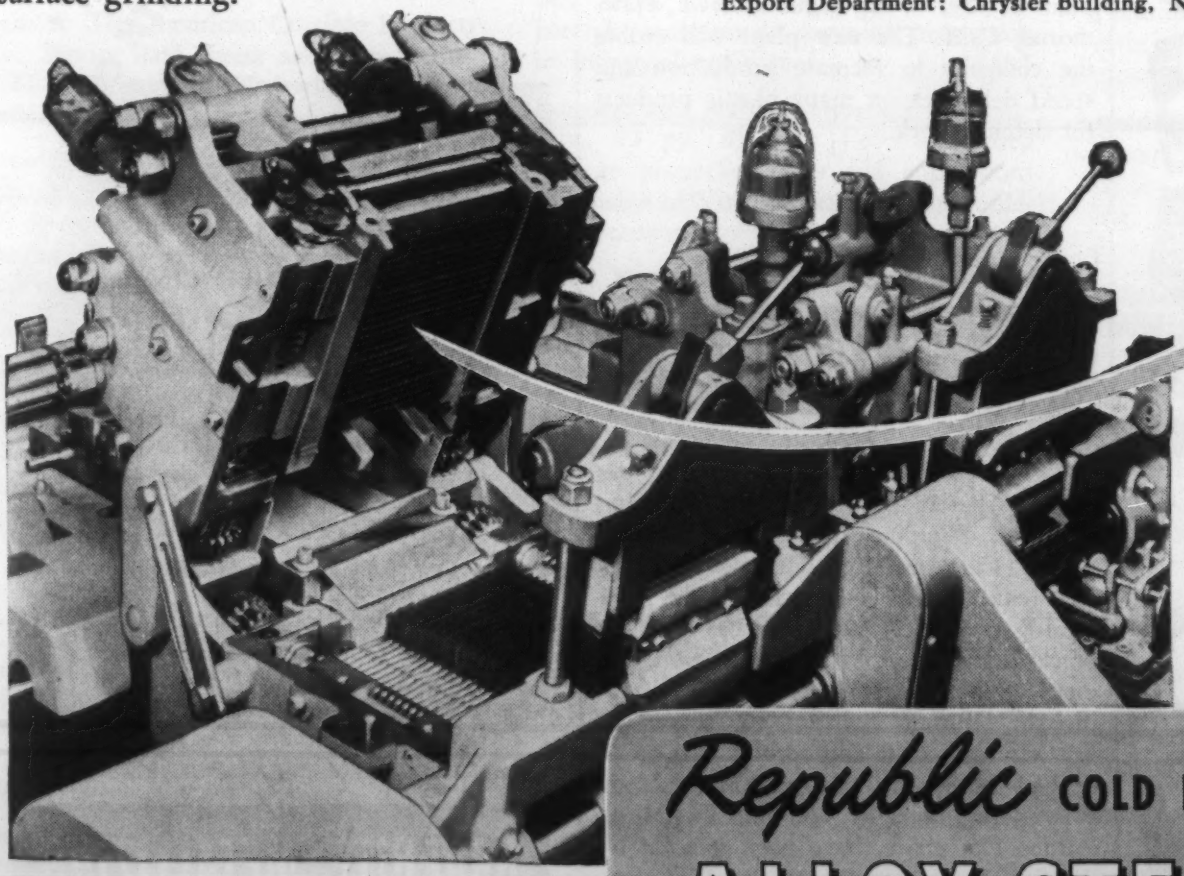

A walk thru your plant may turn up idle scrap... call your scrap dealer *TODAY*

Republic COLD DRAWN
REPUBLIC STEEL
ALLOY STEEL BARS

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

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Available in two sizes 6" and 12" throat depth

New
DOUBLE PURPOSE PRESS

Now you can punch holes of various shapes as large as 4" in diameter in 16 gauge steel — also blank, draw, emboss, form,—all with the new DI-ACRO Punch. It is ideal for both experimental and production work.

The precision ground triangular ram of this double purpose press prevents punch head from turning, assuring perfect alignment at all times.

A Turret Stripper of exclusive DI-ACRO design automatically strips material from punches of all shapes. Roller Bearing cam action develops 4-ton pressure with minimum effort. Adjustable gauges assure exact location of holes.

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giving full details on all DI-ACRO Hydra-Power Benders, Power Shears, Brakes, Rod Parters, Notchers, Punches — also our offer of free DI-ACRO Engineering Service.

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News Digest

tions a unit for recovering sulfur from waste refinery gases. Output of the new unit will be sold for conversion to sulfuric acid.

Ferro Corp's eighth foreign plant started into production at the end of September with the opening of *Ferro Enamel de Mexico* in Mexico City. The newest Ferro plant is expected to produce 5 million lb of frit annually for Mexican appliance and ceramic industries.

John Mohr & Sons has announced the incorporation of a subsidiary company, the *Mohr Open Hearth Div., Inc.*, which has been formed to engage in all phases of open hearth engineering and construction.

Westinghouse Electric Corp. will undertake a $296,000,000 expansion program extending beyond 1953, according to a recent company statement.

A new jet engine parts plant was recently dedicated by *Solar Aircraft Co.* in Des Moines. The new Wakonda plant will manufacture hot end parts for the latest jet engines using techniques that employ the maximum number of automatic machines and assembly line methods.

Lepel High Frequency Laboratories has moved into its new building in Woodside, L. I., N. Y. According to the company's president, the new plant will enable Lepel to triple the production of high frequency heating equipment.

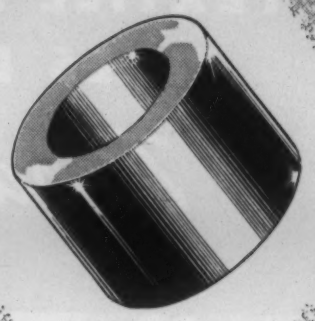
Extruders, Inc. has moved into its new plant at 3232 W. El Segundo Blvd., Hawthorne, Calif. The new plant will enable the company to increase production and speed deliveries on many plastic products for defense work.

News of Societies

The American Welding Society has elected Charles H. Jennings, Engineering Manager, Welding Dept., Westinghouse Electric Corp. as its president for 1951-52. Mr. Jennings has been active in the Society for the past 20 years and has held the offices of chairman, Pittsburgh Section, and district vice president, director at large and director, Buffalo Section. He served as first vice president and second vice president of the Society. Edwin L. Marshall, of New York University, and Stan Spaulding, Purdue University, have been selected by the Society as winners of the $200 first prize and the $150 second prize respectively, in the 1951 A. F. Davis Undergraduate Welding Award. "Arc Welded Tractor" was the subject of Mr. Marshall's

(Continued on page 200)

WORKS WHERE OTHERS WON'T



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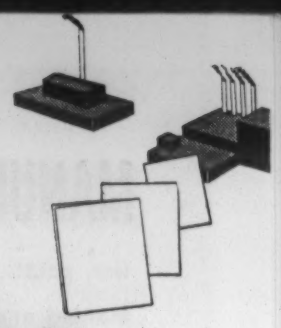

MANUFACTURERS' LITERATURE

Materials

Irons • Steels

Stainless Steel. Armco Steel Corp., 4 pp, ill. Describes cost savings in the brewery industry effected by the use of stainless steels. Suggestions on obtaining best results with stainless. (1)

Stainless Steels. G. O. Carlson, Inc., 4 pp, ill. Descriptions of this company's stocks of stainless steel plates, heads, disks, rings, forgings, billets, bars and other products. (2)

High-Speed Steels. Climax Molybdenum Co. Booklet discusses the advantages of molybdenum high-speed steels for taking the place of tungsten steels in tools. (3)

Tool Steel Selector. Crucible Steel Co. of America. Circular slide calculator enables the choice of the proper tool steel to fit the given working conditions. (4)

Casting Steels. Unitcast Corp. Plastic Slide indicator gives handy description of properties and compositions of various steels for use in steel castings. (5)

Nonferrous Metals

Babbitt. The American Crucible Products Co. Service data sheets and price quotations on Promet XXX lead-base babbitt. Includes properties and applications. (6)

Aluminum Bronze Alloys. Ampco Metal, Inc., 20 pp, ill, No. PI-3. Detailed data on corrosion resistance and properties of various aluminum bronze alloys for corrosive applications. (8)

Copper-Base Casting Alloys. Barth Smelting Corp., 40 pp, ill. Detailed Federal, Navy, ASTM, SAE and AMS specifications for nonferrous ingots and castings, plus data on purchase and use of ingot metals. (9)

Magnesium. Brooks and Perkins, Inc. *Focus on Magnesium* has table of magnesium alloy characteristics, design data and applications. (10)

Low-Temperature Melting Alloys. Cerro de Pasco Corp., 8 pp. Describes, in some detail, the process of mold-making with this company's low temperature melting alloys. (11)

Rhodium. Sigmund Cohn Mfg. Co., 4 pp. Properties of rhodium and its value in electroplating due to its color, hardness and high corrosion resistance. (12)

Magnesium. The Dow Chemical Co., 8 pp, ill, Vol. 2, No. 4. *Magnesium Topics* discusses up-to-date developments in processing and utilization of magnesium. (13)

Titanium Carbide. Kennametal, Inc., 4 pp, ill, No. 1050. Description and properties of Kentanium, titanium carbides with high heat and thermal shock resistance. Describes forming methods. (14)

Metal Hydrides. Metal Hydrides, Inc., 4 pp. Describes metallurgical and chemical hydrides, their use in alloying, hydrogen production, reduction of compounds, etc. (15)

Nonmetallic Materials • Parts

Rubber Parts. Acushnet Process Co., New Bedford, Mass. Rubber Handbook shows variety of rubber parts company can make to order. Request from Acushnet on company letterhead.

Felt Vibration Mounts. American Felt Co., 16 pp, ill. Discusses simple method for selection of the right grades and weight of felt for reducing transmitted vibration of machine tools 85%. (16)

Extruded Plastics. Anchor Plastics Co., Inc., 8 pp, ill, No. AP51. Latest applications of custom-made thermoplastic extrusions. Includes properties of thermoplastics and types of extrusions available. (17)

Rubber Parts. Automotive Rubber Co., Inc. Series of bulletins show use of rubber for insulation or corrosion prevention in industrial equipment. (18)

Extrusion and Molding Materials. Bakelite Div., 22 pp, ill, No. J-675. Detailed average properties, uses and suggestions for design of Vinylite extrusion and molding compounds. (19)

Glass Electrical Products. Corning Glass Works, 8 pp, ill, No. B-88. Electrical applications of various types of glass. Includes tables of electrical and physical glass properties. (20)

Insulating Material. Dow Corning Corp., No. 10. *Silastic Facts* gives properties, performance and applications of Silastic, silicone insulator said to have good thermal stability. (21)

Glass Products. Dunbar Glass Corp., 4 pp, ill. Descriptions of this firm's various industrial glasses. Explains advantages of glass to the designer and gives physical properties. (22)

Synthetic Rubber Products. E. I. du Pont de Nemours & Co., Inc., Rubber Chemicals Div., 8 pp, ill, No. 47. *Neoprene Notebook* discusses latest developments in Neoprene rubber and its applications. (23)

Flexible Tubing. Flexible Tubing Corp., 8 pp, ill, No. 5-4. Applications and performance data on Spiratube flexible tubing for ventilation and materials conveying. (24)

Molded Plastics. General Electric Co., Chemical Dept., 8 pp, ill, No. 1d/Ge. Properties, characteristics and applications of this company's molded thermosetting and thermoplastic parts. (25)

Plastic-Faced Plywood. Georgia-Pacific Plywood Co. Properties, applications and available forms of GPX plastic-faced plywood, said to be remarkably resistant to adverse conditions. (26)

Polyvinyl Plastics. B. F. Goodrich Chemical Co., 16 pp, ill. Properties and descriptions of Geon resins for such applications as extrusions, wire and cable, flooring and molded parts. (27)

Rubber Products. B. F. Goodrich Co., 26 pp, ill, Nos. 2200-2850. Features, recommended service and specifications of various types of rubber conveyor belts. (28)

Rubber Reinforcing Resin. Goodyear Tire & Rubber Co., Chemical Div., No. 601-B. Features and applications of Pliolite S-6B resin giving great plasticity in rubber processing at low temperatures. (29)

Molded Plastics. The Grigoleit Co. Folder describes this company's facilities for producing molded plastics. Includes designing, engineering, tooling, molding and finishing. (30)

Cellulose Acetate. Hercules Powder Co., Cellulose Products Dept., 4 pp, ill. Shows two case histories in which flame-resistant cellulose acetate is used and the advantages of its use. (31)

Fiber Glass Reinforcements. Libbey-Owens-Ford Glass Co., 12 pp, ill, No. F-1. Describes company facilities and their application, gives specifications and descriptions of fiber glass yarns and insulation. (32)

Synthetic Industrial Crystals. Linde Air Products Co. Properties, available forms and typical applications of various industrial gems described in new folder. (33)

Carbon Products. Morganite, Inc., 8 pp, ill, No. lf. Specifications of various carbon bearings and bushings. Also properties of six series of Morganite carbon products. (34)

Alumina. Reynolds Metals Co., 8 pp, ill. Descripition of production of alumina and its application to such materials as plas-

To obtain literature appearing on these pages, please refer to easy-to-use reply card on page 197.

MANUFACTURERS' LITERATURE

tics, paints, alloy steels and inks. (35)

Molded and Laminated Plastics. The Richardson Co., 4 pp, ill. Describes types of plastics this company can fabricate and shows numerous examples of the products produced, the services available. (36)

Fibrous Sheet Materials. Rogers Corp., 19 pp. ill. Data sheets on Rogers Duroids giving properties, test values and applications of each particular Duroid. (37)

Cast Acrylic Sheet. Rohm & Haas Co., Plastics Dept., 5 pp, No. 68. Properties, fabrication and forming information, and applications of Plexiglass II, heat resistant plastic adapted to weathering. (38)

Closed Cellular Rubber. Rubatex Div., Great American Industries, Inc., No. RBS-4-51. Detailed properties and concise explanations of advantages of Rubatex closed cell rubber. Includes samples. (39)

Carbon and Graphite Parts. Stackpole Carbon Co., 44 pp, ill. Properties and applications of varieties of this company's carbon and graphite parts used in modern equipment. (40)

Molded Ceramics. Star Porcelain Co. Gives technical data on characteristics of molded ceramic products for electrical wiring, electrical heating and special purposes. (41)

Laminated Plastics. Synthane Corp. Mechanical, electric and chemical characteristics of this company's laminated plastics described in catalog. Includes applications and descripitions. (42)

Laminated Plastics. Taylor Fibre Co., 62 pp, ill. Describes this company's vulcanized and phenol laminates, giving data for selection and ordering, recommended uses and design helps. (43)

Molded Thermoplastics. Tri-State Plastic Molding Co., Inc. Folder describes this company's facilities for producing to order thermoplastics parts by injection molding. (44)

Plastics Parts. United States Gasket Co., 48 pp, ill. Catalog describes properties and uses of Teflon, this company's various Teflon products and also gaskets of various materials. (45)

Carbon Graphite. U. S. Graphite Co., 4 pp, ill. Describes Graphitar, carbon-graphite nonmetallic that is chemically resistant, self-lubricating, hard, light and won't warp. (46)

Plastic-Rubber Materials. U. S. Rubber Co., 8 pp, ill, No. M-0133. Description, properties, machinability and uses of Enrup plastics, said to fill the gap between rubbers and plastics. (47)

Thermoplastic. Van Dorn Iron Works Co., 16 pp. Technical data on properties, available forms, fabrication and applications of Lucoflex, a rigid polyvinyl chloride. (48)

Felt. Western Felt Works, 32 pp, ill. History of manufacture and uses of felt, including brief description of present-day methods and applications. (49)

Nonmetallic Gears. Westinghouse Electric Corp., 15 pp, ill, No. B-4661. Description and applications of Micarta gears. Includes tables of properties, gear data and preferred pitches. (50)

Flexible Hose. The Wiremold Co., 4 pp, ill, No. 567. Description, applications and types of this firm's flexible reinforced rubber air ducts for finishing applications. (51)

Metal Parts • Forms

Die Castings. The Accurate Die Casting Co., 24 pp, ill. Shows company's facilities for producing to order all types of zinc and aluminum die castings. Includes table of alloy properties. (52)

Precision Castings. The Adapti Co., Investment Casting Div. Brochure explains precision casting methods and shows by numerous applications how they are used. (53)

Aluminum Parts. Aluminum Goods Mfg. Co., 56 pp, ill. Catalog covers extensive production facilities and technical services for producing wide range of parts. (54)

Bonded Metals. American Nickeloid Co., 16 pp, ill. Fabricating information and suggestions, applications and tables of properties and sizes of Nickeloid Metals. (56)

Small Swaged Parts. The Bead Chain Mfg. Co. Catalog describes Multi-Swage process for swaging small metal parts from flat stock. Shows advantages and applications of method. (57)

Welded Steel Tubing. Brainard Steel Co., Tubing Div., 8 pp, ill. Specifications, advantages and applications of various types of welded mechanical steel tubing. (58)

Steel Tubing. Bundy Tubing Co., 20 pp, ill. Properties, specifications and typical parts of Bundyweld double-walled copper-coated steel tubing. (59)

Stainless Tubing. The Carpenter Steel Co., 16 pp. *Corrosion Notebook* describes general types of corrosion and gives data on corrosion resistance of various types of stainless tubing and pipe. (60)

Investment Castings. Casting Engineers, Inc. *Cost Reductions Through Investment Castings* describes investment casting process, its advantages and cost-saving applications. (61)

Thermostatic Bimetal. W. M. Chace Co., 4 pp, ill, No. 1a/10. Properties of thermostatic bimetals and formulae to use in application to temperature responsive devices. (62)

Corrosion Resistant Castings. The Duraloy Co., 16 pp, ill, No. 3150-G. Describes facilities for manufacture of chromium-iron and chromium-nickel castings. Gives detailed properties of alloys and their uses. (63)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (64)

Investment Castings. Engineered Precision Casting Co., 4 pp, ill. Describes Epco Precision Investment Castings. (65)

Steel Castings. Farrell-Cheek Steel Co., 4 pp, ill, No. 40. Examples of the intricate electric furnace carbon and alloy steel castings produced by this company. (66)

Investment Castings. Gray-Syracuse, Inc., 4 pp, ill. Various parts of precision-cast brass, bronze, beryllium copper and steel. (67)

Investment Castings. Haynes Stellite Co. Describes manufacture of investment castings, their advantages and some applications in which costs were cut. (68)

Die Castings. The Hoover Co., 12 pp, ill, No. 853. Shows this company's facilities for producing zinc and aluminum die castings. Includes design helps, describes applications. (69)

Permanent Magnets. Indiana Steel Products Co., 34 pp, *Permanent Magnet Manual* No. 3. Uses, types and materials of permanent magnets. Includes design data. (70)

Beryllium Copper Springs. Instrument Specialties Co., 12 pp, ill, No. 6. Catalog shows typical properties and applications of beryllium copper springs and electrical contacts. (71)

Precision Cast Parts. The Jelrus Co., Inc. Advantages of centrifugal precision casting for custom manufacture of complex parts accurately and quickly. (72)

Powdered Metal Parts. Keystone Carbon Co., Inc., 36 pp, ill. Describes successful applications of powder metallurgy, gives data on correct design of powdered metal parts and detailed information on powdered metal bearings. (73)

Stampings. Laminated Shim Co., Stampings Div., 12 pp, ill. Describes facilities for producing good quality stampings to specifications, facts to be considered in ordering stampings and other data. (74)

Pressed Parts. Lenape Hydraulic Pressing and Forging Co. Catalog shows numerous press-formed parts illustrating the kinds of jobs this firm can perform. (75)

Ductile Iron Castings. Lynchburg Foundry Co., 12 pp, ill. Describes ductile cast iron with detailed description of its properties and suggested applications. (76)

Iron Castings. Meehanite Metal Corp., 4 pp, ill, No. 32. Detailed tabular summary of physical properties of Meehanite high quality gray iron castings. (77)

Precision Castings. Microcast Div., Austenal Laboratories, Inc., 16 pp, ill. Numerous applications of microcasting, its advantages and design considerations and the types of metals that can be Microcast. (78)

Die Castings. Monarch Aluminum Mfg. Co. File data on aluminum and zinc die castings and aluminum mold castings showing applications, advantages and this

company's facilities for making them. (79)

Spun Shapes. Phoenix Products Co., Metal Spinning Div., 4 pp, ill. Describes Phoenixspun method spinning spherical and extra deep-drawn contours. (80)

Metal Powders. Plastic Metals Div., 4 pp, ill, No. 567. Describes applications, advantages and limitations of powder metallurgy for custom-making parts. (81)

Stainless Steel Tubing. Republic Steel Corp., 28 pp, ill. Detailed data on Electrunite stainless tubing, its fabrication, corrosion resistance, applications and other helpful information. (82)

Aluminum Extruded Shapes. Reynolds Metals Co., Aluminum Div., 4 pp, ill. Advantages, length classifications and alloys and tempers of aluminum extrusions. Includes tolerances and mechanical properties. (83)

Rigid Metal Sheets. Rigidized Metals Corp., 4 pp, ill, Vol. 1, No. 3. Numerous applications of Rigidized Metals showing their advantages and versatility. (84)

Forgings. Joseph T. Ryerson & Son, Inc., 4 pp, ill. Shows various forms that can be flat die forged or drop forged by this company. Describes advantages of forgings and facilities for treating them. (85)

Spun Metal Parts. Spincraft, Inc., No. 3. Data book on metal spinning and fabricating gives data on process and help in designing for economical production. (86)

Ferrite Parts. D. M. Steward Mfg. Co., 4 pp, ill. Brief description of ferrites, suggested uses, their properties and an application showing the advantages of ferrites as transformer cores. (88)

Spun Metal Parts. Roland Teiner Co., Inc., 4 pp. Describes facilities for spinning metal parts of all types of metal, including stainless steels. (89)

Bonded Aluminum and Steel. Arthur Tickle Engineering Works. Booklet describes Alumibond method for bonding aluminum to steel, its advantages and applications. (90)

Centrifugal Cast Parts. U. S. Pipe and Foundry Co., 12 pp, ill. Describes centrifugal casting process and advantages, and shows three applications improved by this method. (92)

Light Metal Shapes. R. D. Werner Co., 4 pp, ill. Explains relative merits of cold roll forming and extruding light metal shapes. Shows company's facilities for both types of fabrication. (93)

Spun Tubing. Wolverine Tube Div., 28 pp, ill. Advantages and numerous applications of this firm's nonferrous Spun End Tube Process. (94)

Stainless Clad Steel. Alan Wood Steel Co., No. D-97. Properties, advantages and applications of Permaclad, stainless clad mild carbon steel said to combine advantages of both. (95)

MANUFACTURERS' LITERATURE

Coatings • Finishes

Protective Coatings. R. M. Hollingshead Corp., ill. Folder describes Klad Kote corrosion preventives, gives detailed specifications, uses, description and other data in tabular form. (96)

Protective Coating. Maas & Waldstein Co., No. 117. Technical data on Water Dip #33, protective coating for plated metal surfaces said to afford good oxidation protection. (97)

Silicone-Base Finish. Midland Industrial Finishes Co. Brochure describes characteristics of Sicon silicone-base finish said to be exceptionally heat resistant. (98)

Protective Covering. Nox-Rust Chemical Corp. Booklet describes Vapor-Wrapper, chemically treated paper said to protect metals against corrosion without use of oil or grease. (99)

Wear Resistant Coating. Parker Rust Proof Co., 12 pp, ill, No. A1062. Advantages of using Parco Lubrite, method of application, typical coating equipment and typical parts which are benefited. (100)

Coatings. Pierce & Stevens, Inc., 16 pp, ill. This company's facilities and services for providing quality lacquers and coatings for various purposes, adhesives and other products. (101)

Industrial Protective Coatings. United Chromium, Inc., 4 pp, ill, No. MC-2. Describes Ucilore industrial coatings for corrosion protection of wood, metal and concrete. (102)

Corrosion Resistant Coatings. U. S. Stoneware Co., 16 pp, ill, No. 720. Features, chemical resistance and recommended methods for application of Tygon plastic paints for use on concrete and metals. (103)

Sealing Process for Castings. Western Sealant, Inc., 7 pp, ill. Discusses process for eliminating porosity from metal castings and fiberglass laminates without visible effects. (104)

Methods and Equipment

Heat Treating • Heating

Induction Heating. Ajax Electrothermic Corp. Technical Bulletins describe induction heating equipment for scale-free heating of steels. (105)

Heat Treating Equipment. American Gas Furnace Co., No. C-1303. Catalog shows AGF oven and pot furnaces, flow meters, gas carburizers and other heat treating equipment. (106)

Hardening Compound. Doughty Laboratories, Inc., 8 pp, ill. Sample testimonials of the value of Hard-N-Tuff steel hardening compound for hardening steel parts, and directions for its use. (108)

Electric Sintering Furnaces. The Electric Furnace Co., 4 pp, ill. Descriptions and uses of nine EF sintering furnaces. (109)

Gas Heating Units. Gas Appliance Service, Inc., 4 pp, ill, No. 511. Shows various types of conveyor- and turntable-type heating units for volume brazing, soldering, annealing and hardening. (110)

Electric Furnaces. Hevi Duty Electric Furnace Co., No. HD 441. Features and advantages of this company's electric furnaces. Describes applications. (111)

Radiant Heating. Holcroft & Co., 8 pp, ill. Advantages, characteristics and limitations of radiant tube heating. Details on

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burner performance and design. (112)

Inert Gas Generators. C. M. Kemp Mfg. Co., No. I-10. Features, specifications and advantages of this company's inert gas generators for heat treating applications. (113)

Brazing Furnaces. Lindberg Engineering Co., 8 pp, ill, No. 210. Features and advantages of this firm's mesh belt and roller hearth continuous production brazing furnaces. (114)

Soaking Pit. Loftus Engineering Corp., 4 pp, ill. Features and advantages of this firm's soaking pits for heating steel ingots. (115)

Brass Cake Heating Furnace. W. S. Rockwell Co., 2 pp, ill, No. RF-6. Technical description of this firm's continuous cycle furnace for heating brass cakes. Includes specifications. (117)

Heat Treating Equipment. Rolock, Inc., 36 pp, ill, No. B-7. Complete line of metal carriers for such operations as quenching, tempering, carburizing and metal cleaning. (118)

Conveyor Furnace. Sargeant & Wilbur, Inc., ill. Features, specifications and advantages of this firm's conveyor furnace for bright brazing, hardening and annealing of stainless steel. (119)

Heat Treating Equipment. Surface Combustion Corp., 4 pp, ill, No. SC-154. Bulletin discusses heat treatment of various types of large caliber ammunition with a view to selecting proper furnace equipment. (120)

Induction Heaters. Westinghouse Electric Corp., 12 pp, ill, No. B-4782. Case histories showing applications, advantages and versatility of this company's equipment for induction heating. (121)

Heating Units. Edwin L. Wiegand Co., No. 50. Catalog describes this company's industrial heating units, giving specifications and features. (122)

Cleaning • Finishing

Wet Blasting Equipment. American Wheelabrator & Equipment Corp., 4 pp, ill, No. 23. Features, applications and specifications of this company's new Liquamatte wet blasting units. (123)

Polishing and Finishing Equipment. Elgin National Watch Co. Industrial Products Div., 4 pp, No. 303. Prices and descriptions and Dymo accessories for use with diamond compounds. (124)

Power-Driven Brushes. The Fuller Brush Co., 32 pp, ill. Describes Fullergript brushes, their application to such processes as scrubbing steel sheet and tampico brushing. (125)

Finishing Equipment. The Murray-Way Corp. Catalog describes full line of this firm's automatic polishing, buffing and grinding equipment. (126)

Metal Cleaner. Niagara Alkali Co. Pamphlet gives properties of Nialk Trichlorethylene, high quality metal-cleaning and degreasing agent. (127)

Metal Cleaning. Northwest Chemical Co., 2 pp. Describes "Lo-Hi" two-tank process for the preparation of metals for plating and vitreous enameling. (128)

Metal Cleaners. Oakite Products, Inc. *Some Good Things to Know About Metal Cleaning* discusses economical methods of removing various undesirable substances from metal surfaces. (129)

Industrial Brushes. Pittsburgh Plate Glass Co., Brush Div., Dept. W-4, 3221 Frederick Ave., Baltimore, Md. Case histories indicate economies available to users of Pittsburgh brushes. Request on company letterhead direct from Pittsburgh Plate Glass.

Mechanical Finishing. Roto-Finish Co. Folder describes uses and economies of Roto-Finish tumbling-type equipment for precision grinding, deburring and coloring metals. (130)

Welding • Joining

Aluminum Fasteners. Aluminum Co. of America, 8 pp, ill, No. AD-244. Descriptions and specifications of this firm's standard and miscellaneous fasteners and screw machine products. (131)

Resin Adhesive. American Cyanamid Co., 8 pp, ill. Discusses features of Urac 180 resin adhesive, indicating uses in plywood pressing, wood bonding, etc. (132)

Silver Brazing. American Platinum Works, 48 pp, ill. Reference manual on silver brazing discusses low temperature brazing, brazing alloys, design considerations and other topics. (133)

Low Hydrogen Electrodes. Arcos Corp., 8 pp. Question and answer description of low-hydrogen electrodes for welding high tensile steels. Lists electrodes, coating types and uses. (134)

Bonding Resins. Ciba Co., 4 pp, ill. Properties of new group of resins, their applications as adhesives for metals and nonmetallics, moldings and coatings. (135)

Welding Positioners. Cullen-Friestadt Co., ill. Catalog shows line of hand- or power-operated welding positioners with capacities up to 30,000 lb. (136)

Welding Rods. Eutectic Welding Alloys Corp., ill. Data file consisting of numerous pamphlets and bulletins on welding, its applications in salvage, repair and fabrication, other helpful data. (137)

Solder. Federated Metals Div., 36 pp, ill. Data on the selection of solders for specific applications, their properties and their use. Tells the role of fluxes and how to prepare the work. (138)

Soldering Compound. Fluxolder Products Co., 20 pp, ill. Describes use and advantages of Fluxolder, powdered solder in flux, for tinning and sweat soldering. Shows grades of Fluxolder and uses. (139)

Brazing. Handy & Harman, ill, No. 54. *Brazing News* describes applications and developments of Easy-Flo and Sil-Fos low temperature silver brazing alloys. (140)

Welding High Nickel Alloys. The International Nickel Co., Inc., 44 pp, ill, No. T-2. Detailed technical data on both electric arc and gas welding of nickel and high nickel alloys. (142)

Stainless Steel Electrodes. The McKay Co., 48 pp. Data on arc welding of stainless steels giving specific uses of alloying elements and specifications of each type of McKay stainless steel electrode. (143)

Induction Brazing. The Ohio Crankshaft Co. *Typical Results of Tocco Induction*

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Brazing and Soldering shows by case histories the advantages of these fastening methods. (144)

Fasteners. Shakeproof Inc., 24 pp. ill, No. AS-42. Booklet shows numerous types of this company's fasteners so arranged as to help the designer choose the best fastener for his job. (145)

Fasteners. Tinnerman Products, Inc., 24 pp, ill. Discusses qualities of Speed Nut fasteners describing tests they must survive, their properties and costs, the ways they are produced. (147)

Lock Nuts. Townsend Co., 2 pp, ill. Features and specifications of Tufflok nuts, special nuts with nonmetallic insert on top of nut to provide tight grip. (148)

Forming • Casting • Molding • Machining

Drawn Shell Trimmer. Dayton Rogers Mfg. Co., 4 pp, ill, No. F-25A. Features, applications, operating directions and specifications of drawn shell trimmer said to enable lower die costs. (149)

Die Casting Machines. Kux Machine Co. Catalog shows complete line of die casting machines, including specifications and features. (150)

Hydraulic Presses. Lake Erie Engineering Corp., 12 pp, ill, No. 4.1. Descriptions of several side housing double- and triple-action presses ranging from 150 to 1000 tons. (151)

Machining Hard Metals. The Method X Co., 4 pp, ill, No. SA1018. Features, operation, tolerances and applications of new machine said to facilitate fabrication of sintered carbides, S-816, etc. (152)

Metal Forming Machines. O'Neil-Irwin Mfg. Co., 40 pp. Details and specifications of Di-Acro power benders, power shears, breaks, rod parters, notchers and punches. (153)

Plastics Molding Press. F. J. Stokes Machine Co., 4 pp, ill, No. 503. Description and specifications for automatic plastics press. Typical products shown. (154)

Drilling Machine. Wales-Strippit Corp., No. DM. Description, specifications and advantages of this company's precision drilling machine. (155)

Adjustable Perforating Dies. S. B. Whistler & Sons, Inc. Catalog describes this company's adjustable perforating dies, their advantages and specifications. (156)

Inspection • Testing • Control

Laboratory Microscopes. Bausch & Lomb Optical Co., 24 pp, ill, No. D-185. Descriptions and specifications of various microscopes for such uses as metallurgical microanalysis. (157)

Metallograph. Bausch & Lomb Optical Co., 20 pp, ill, No. E-232. Features of Balphot metallograph for microscopic examination of metallographic specimens. (158)

Films for Surface Analysis. The Brush Development Co., ill, No. 653. Applications of, and equipment for using Faxfilm for microscopically examining surfaces of various materials. (159)

Industrial Radiography. Eldorado Mining & Refining (1944) Ltd., Dept. W. Up-to-date information on nondestructive testing of metals by gamma radiography. (160)

Universal Testing Machine. National Forge and Ordnance Co., No. 501. Features, specifications and accessories of this company's table model universal testing machine. (161)

Testing Machines. Tinius Olsen Testing Machine Co., 8 pp, ill, No. 40. Describes new line of hydraulic testing machines for tension, compression, transverse and flexure testing. (162)

Temperature Controls. The Pyrometer Instrument Co., No. 150. Catalog shows Pyro Immersion Pyrometer, accurate instrument for nonferrous foundry temperature control. (163)

Ultrasonic Testing Apparatus. Sperry Products Inc., ill, No. 50-105. Description, specifications, applications and advantages of Ultrasonic Reflectoscope for nondestructive testing of metals. (164)

Pyrometers. Tagliabue Instruments Div., 34 pp, ill, No. 1101 J. Detailed data on Celectray thermal indicating or recording controllers and accessories designed for high sensitivity and accuracy. (165)

Package Testing. United States Testing Co., Inc., 8 pp, ill. Describes methods for testing packages designed for products up to 1000 lb for vibration and impact. Includes prices. (166)

General

High Vacuum Pumps. Distillation Products Industries. Data on high vacuum pumps of unique design for such uses as metal processing and dehydration. (167)

Materials Controls. Remington Rand Inc., No. KD367. Booklet describes Kardex system for keeping visible materials and parts inventories coordinated with production. (168)

Foundry Blowers. The Spencer Turbine Co., No. 112. Bulletin describes use of Spencer Turbos as blowers for foundries, giving blower features and advantages. (169)

Vacuum Impregnation. F. J. Stokes Machine Co., 22 pp, ill, No. 710. General description of vacuum impregnation, fields of application and descriptions and specifications of this firm's line of impregnating equipment. (170)

On any metal finishing problem

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News Digest

paper, while Mr. Spaulding's article dealt with "Analysis and Design of Welded Pressure Vessels". The Society presented $2,250 to winners of the 1951 Resistance Welder Manufacturers Assn. prize contest at the annual meeting in Detroit. W. L. Roberts, research engineer, Westinghouse Electric Corp., received the top award, $750, for the best paper from an industrial source—"Resistance Variables During Spot Welding". Second prize of $500 was awarded to D. H. Fleig, American Electric Fusion Corp., for a paper on "Design and Operation of High-Speed Production Tube Mills". C. S. Seltzer was the recipient of the third prize, $250, for his paper entitled, "Seam Welding Cylinders Automatically". For the best papers from a university source, Rensselaer Polytechnical Institute won both prizes. Dr Ernest F. Nippes and John N. Ramsey were selected the winners of the $300 first prize for their paper, and Dr. Nippes, with co-authors J. M. Gerken and J. G. Maciora, also won the $200 second prize. William H. Colbert, a mechanical engineering senior of the University of Cincinnati, won the undergraduate award with his paper "Resistance Welding".

American Society for Testing Materials has announced the election of a new vice president—Dr. Harold L. Maxwell, supervisor of general consultants, E. I. du Pont de Nemours & Co., Inc. Dr. Maxwell will serve through the Society's 50th anniversary meeting in June, 1952. A symposium on testing metal powders and metal powder products consisting of several technical papers by leading authorities in the field will be the technical feature of the 1952 spring meeting of the ASTM, which will be held during the week of Mar. 3, at the Hotel Statler in Cleveland.

Engineering student winners of the first national scholarship contest sponsored by the *American Society of Tool Engineers* have been announced. They are: John Wayne Boring, senior at the University of Kentucky; James Alfred Richmann, junior at the University of Iowa; William H. Garlock, senior at the University of Kansas; and William Paul Ryan, senior at Villanova. Awards were made on the basis of the student's own application and the recommendation of his dean or professor, plus his scholastic rating.

The *American Society for Metals* recently dedicated a bronze plaque saluting William P. Woodside, founder of the 38-year old scientific society. The ceremony was the first on the week-long program of the World Metallurgical Congress and National Metal Exposition.

The *Association of Consulting Chemists and Chemical Engineers, Inc.* elected the following officers at the annual meeting: Erwin Di Cyan, consulting chemist, Di Cyan & Brown—president; Earl D. Stewart, director of research, Schwarz Laboratories—vice president.

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Compressive Strength psi	14,100

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60 cycles	0.0011	10^3 cycles	0.0042
1 megacycle	0.026	10 megacycles	0.035
DIELECTRIC CONSTANT			
60 cycles	3.88	10^3 cycles	3.70
1 megacycle	3.49	10 megacycles	3.17
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60 cycles	0.0043	10^3 cycles	0.015
1 megacycle	0.091	10 megacycles	0.110
DIELECTRIC STRENGTH			
step by step (⅛ inch section)			350 Volts/mil
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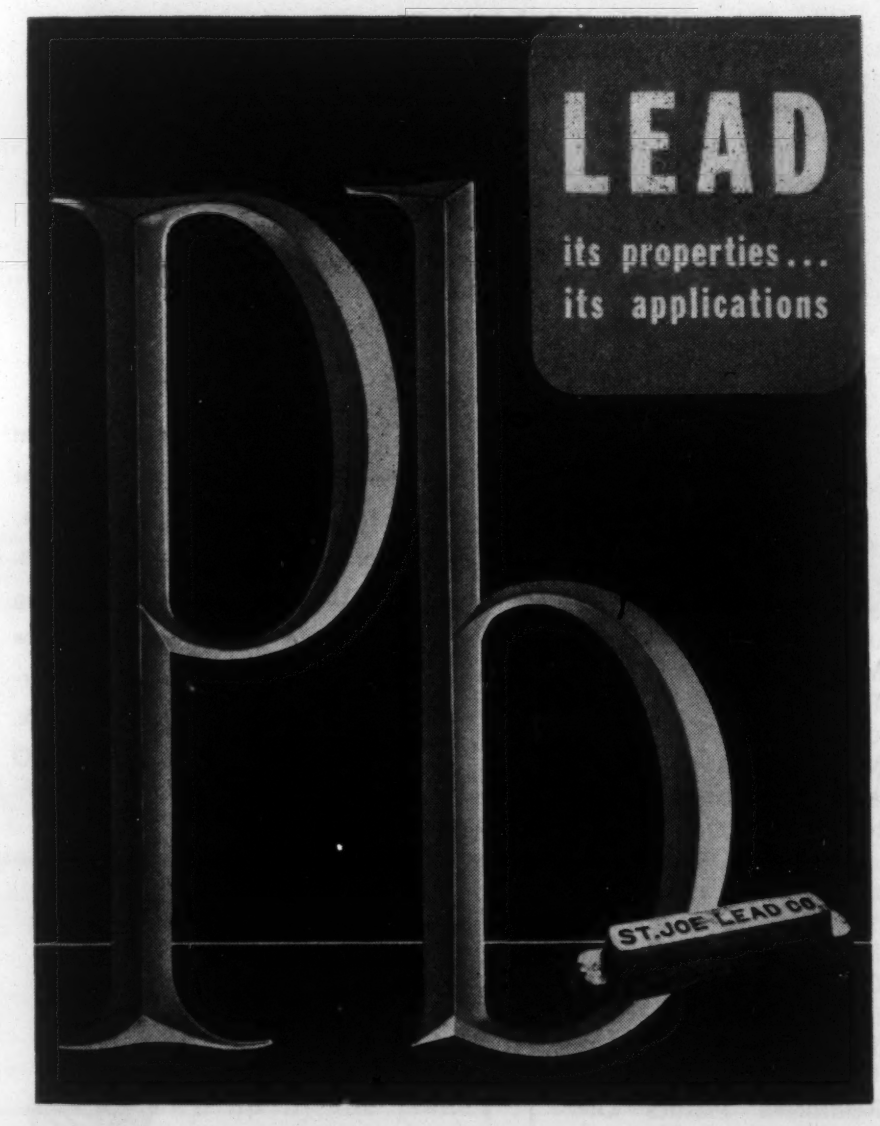

The purpose of this new, 52-page book is two-fold. It describes the major uses of lead, its alloys and compounds plus the various properties which, either singly or in combination, make the respective lead product the logical choice for these applications. To this end, the book has been divided into two parts. The principal properties of lead and related data—gathered from metallurgical papers, technologists in lead producing and consuming industries, textbooks, as well as the research files of the St. Joseph Lead Company's laboratories, and various other sources of information—have been compiled in Part I. The major applications of lead—based on these properties—are covered in Part II. This book should therefore not only serve as a ready reference on the properties of lead, some of its alloys and compounds, but will also show the extent to which these properties are responsible for the use of lead in its various applications.

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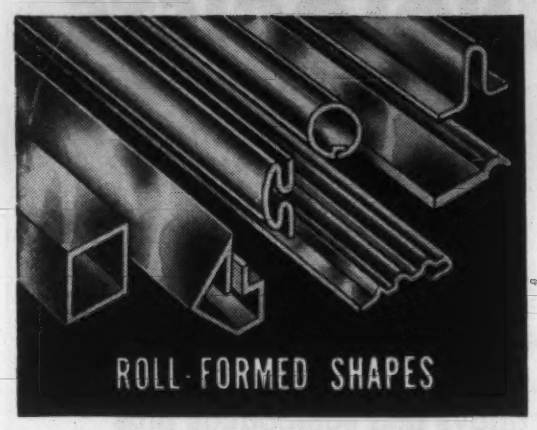

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Meetings and Expositions

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, annual meeting. Philadelphia. Dec. 26-31, 1951.

PLANT MAINTENANCE SHOW AND CONFERENCE. Philadelphia. Jan. 14-17, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit. Jan. 14-18, 1952.

SOCIETY OF PLASTICS ENGINEERS, INC., national conference. Chicago. Jan. 16-18, 1952.

MALLEABLE FOUNDERS' SOCIETY, semi-annual meeting. Cleveland. Jan. 18, 1952.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, annual meeting. St. Louis. Jan. 28-30, 1952.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York. Jan. 28-Feb. 1, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, annual meeting. New York. Feb. 18-21, 1952.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting and committee week. Cleveland. Mar. 3-7, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, passenger car, body and materials meeting. Detroit. Mar. 4-6, 1952.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION, spring meeting. Chicago. Mar. 10-13, 1952.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, annual convention. Galveston. Mar. 10-14, 1952.

SOCIETY OF THE PLASTICS INDUSTRY, annual national meeting. Philadelphia. Mar. 11-14, 1952.

AMERICAN SOCIETY OF TOOL ENGINEERS, annual meeting. Chicago. Mar. 17-21, 1952.

STEEL FOUNDERS' SOCIETY OF AMERICA, annual meeting. Chicago. Mar. 18-19, 1952.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Seattle. Mar. 24-26, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Open Hearth and Blast Furnace, Coke Oven and Raw Materials conference, Iron & Steel Div. Pittsburgh. Mar. 31-Apr. 2, 1952.

SOCIETY OF THE PLASTICS INDUSTRY, Reinforced Plastics Div. meeting. Chicago. Apr. 9-11, 1952.

SOCIETY OF AUTOMOTIVE ENGINEERS, national aeronautical meeting. New York. Apr. 21-24, 1952.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div., New England regional conference. Boston. Apr. 25-26, 1952.

METAL POWDER ASSOCIATION, annual meeting and exhibit. Chicago. Apr. 29-30, 1952.

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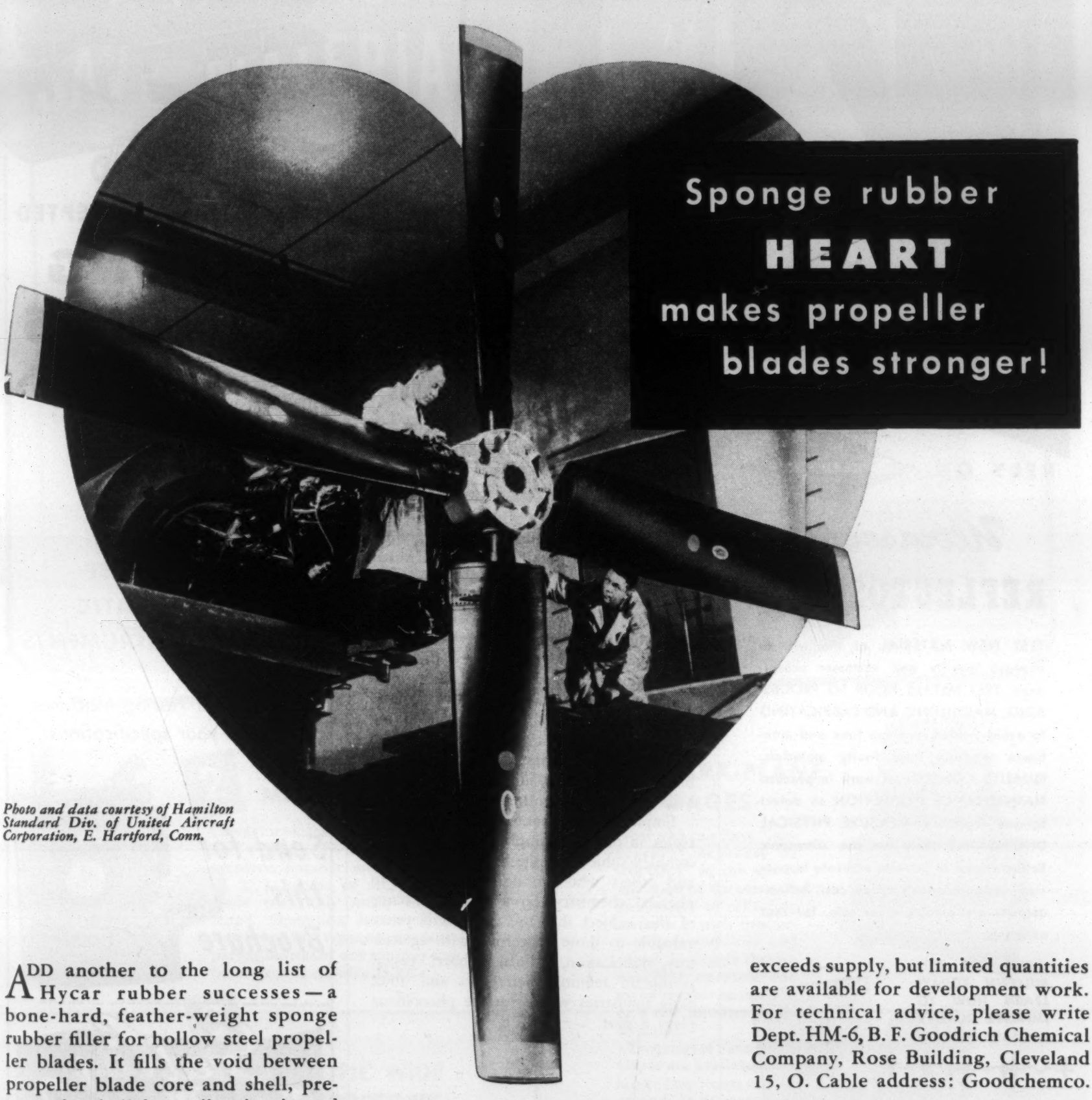

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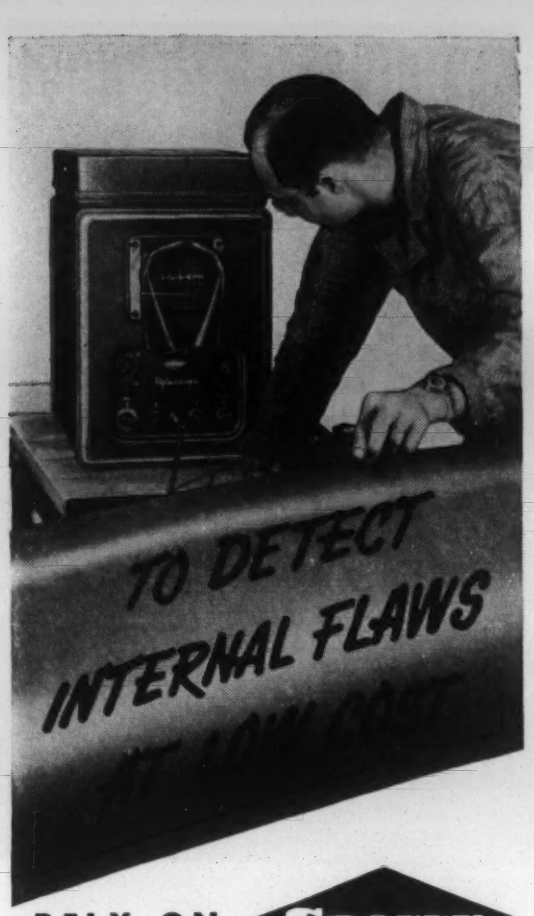

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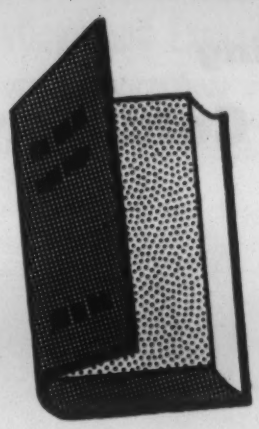

BOOK REVIEWS

The Surface Chemistry of Solids

THE SURFACE CHEMISTRY OF SOLIDS. *By S. J. Gregg. Published by Reinhold Publishing Corp., New York 18, N. Y., 1951. Cloth, 5¾ by 8¾ in., 297 pages. Price $8.50.*

This book is a systematic survey of the various branches of the surface chemistry of solids. It deals with all those chemical and physico-chemical phenomena which relate to the activity of the surface of a solid, or to the interface between a solid and a gas, a liquid or another solid.

The author treats many of these phenomena, such as the adsorption of gases and vapours, the spreading of a liquid over a solid, catalysis and adhesion, with a consistent viewpoint as far as practicable. He summarizes and evaluates the theories of leading workers in these fields.

Emphasis throughout is on general principles in order to simplify an exceedingly complex subject for the benefit of students and others who are not well versed in physical chemistry. So wide is the scope of this subject that this book will prove valuable to those concerned with agriculture, lubrication, paints, rubber, paper, petroleum refining, detergents and other basic industries where surface phenomena plays a part.

Corrosion

CORROSION CAUSES AND PREVENTION. THIRD EDITION. *By Frank N. Speller. Published by McGraw Hill Book Co., New York 18, N. Y., 1951. Cloth, 6¼ by 9¼ in., 686 pages. Price $10.00.*

This revised Third Edition brings you a systematic and authoritative presentation of the theory of corrosion, along with a detailed description of methods of preventing corrosion. Dealing particularly with the ferrous metals, the book tells what corrosion prevention means in elimination of waste—explains corrosion, the kinds there are, and the factors of their

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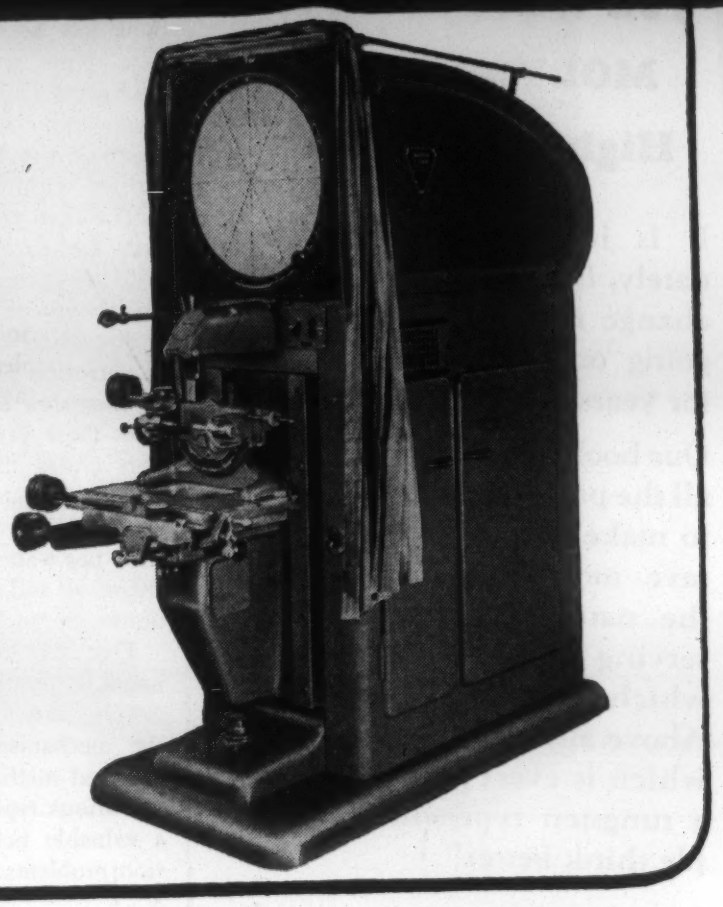

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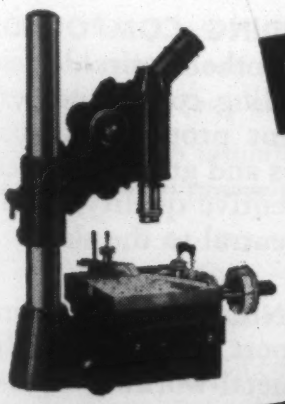

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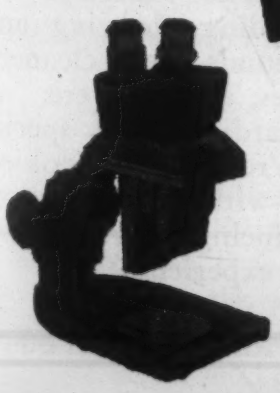

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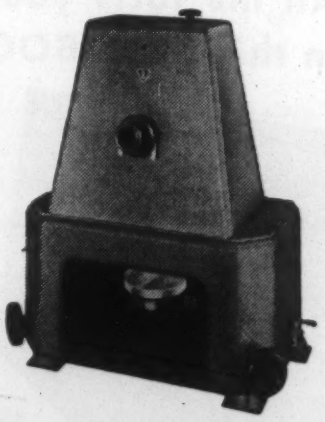

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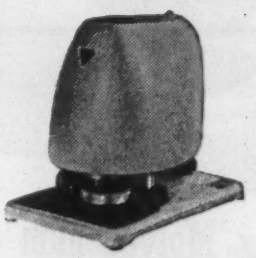

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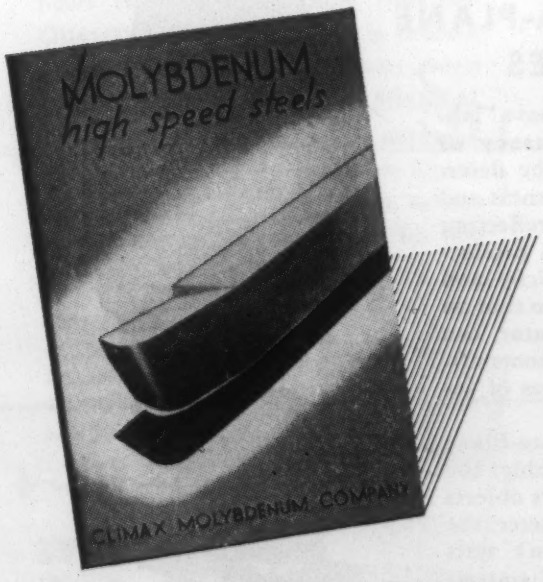

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Book Reviews

(continued)

nature and occurrence—shows how to prevent corrosion in various fields of engineering work—and talks about the economic aspects of corrosion prevention.

All of the material contained in this book has been brought completely up-to-date. New sections have been added on Biological Influence and Cathodic Protection, and the most recent advances in practical preventives have been fully described within reasonable limits.

The first part of the book describes the facts and factors already known, together with the generally accepted Electrochemical Theory of Corrosion. This leads up to a discussion of a system of classification of corrosion phenomena and the principles of corrosion testing. The second part applies these principles to corrosion prevention under the conditions found in the air, underwater, underground, in closed water systems, steam generators, steam and hot-water heating systems, in the chemical industries, and in other situations.

Free of mathematical and thermodynamical terms, this book brings you a simple, easy-to-understand explanation of the mechanism of corrosion and of the practical methods of prevention as applied to various types. The engineer will find it a valuable help in solving specific corrosion problems.

Other New Books

THE HOT-WORKING OF NONFERROUS METALS AND ALLOYS. *Published by the Institute of Metals, London S. W. 1, England, 1951. Cloth, 5¾ by 8¾ in., 208 pages. Price $2.50.* This is Monograph and Report Series No. 9 covering a symposium on the metallurgical aspects of the hot working of nonferrous metals and alloys.

LEAD: ITS PROPERTIES, ITS APPLICATIONS. *Published by St. Joseph Lead Co., New York 17, N. Y., 1951. Paper, 8½ by 11 in., 47 pages. Free of charge.* The purpose of this book is two-fold. It describes the major uses of lead, its alloys and compound, and secondly, covers the various properties which make the lead product the logical choice for these applications. To this end the book has been divided into two parts. The principal properties of lead and related data have been compiled in Part I. In Part II, the major applications of lead—based on these properties—are covered in a series of advertisements prepared for insertion in a number of publications covering the metal-working industries.

INDUSTRIAL FURNACES. FOURTH EDITION. *By W. Trinks. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1951. Cloth, 6 by 9¼ in., 526 pages. Price $10.00.* The fourth edition of Volume I brings this treatise completely up-to-date by incorporating the most recent scientific facts which research has discovered about heat transfer and furnace design, as well as present day design and operating principles and techniques. The revisions combine to make this edition even more useful to those designers and users of industrial furnaces who want to know how to get the best value out of the fuel they use and how to apply it most effectively.

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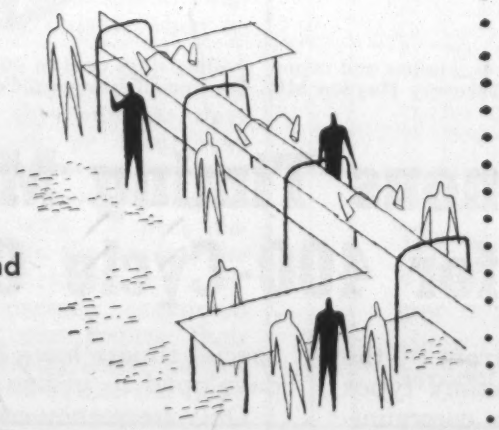

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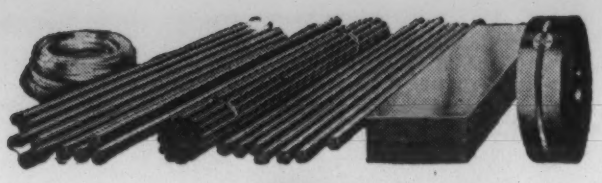

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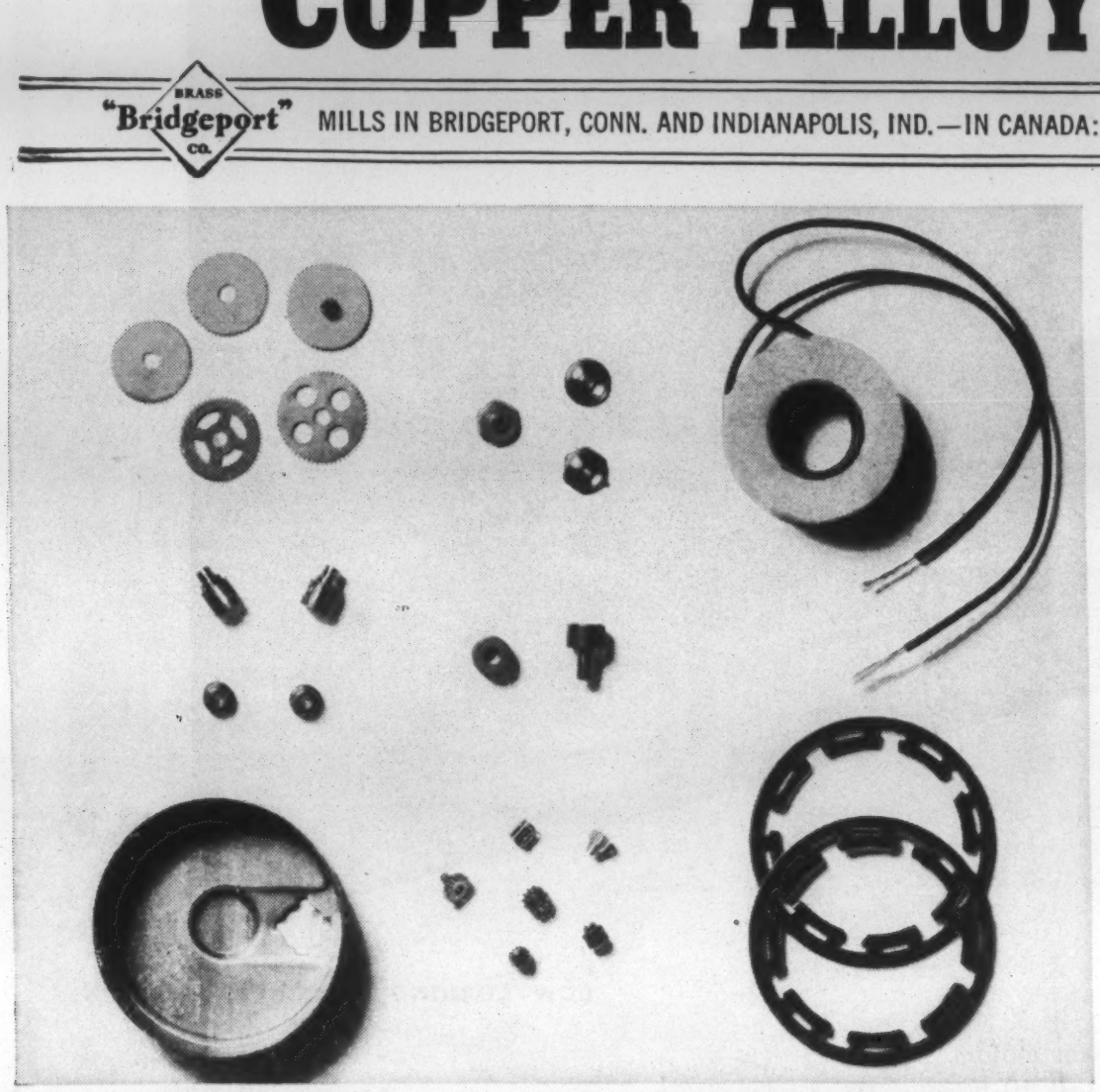
COPPER ALLOY BULLETIN

"Bridgeport" BRASS CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

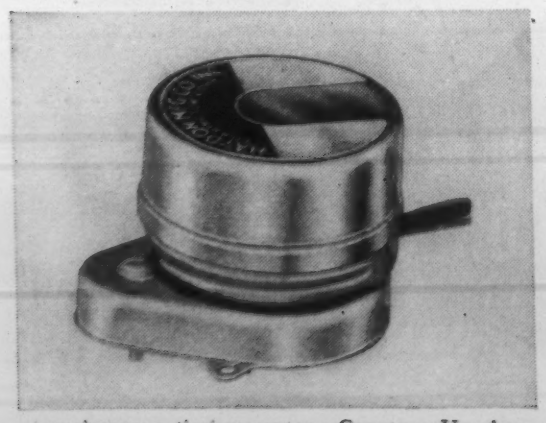


Gears, bushings, coil, motor cover, pinions and copper shading rings used in 400-cycle synchronous timing motor.—Courtesy Haydon Mfg. Co., Inc., Torrington, Conn.

Synchronous Timing Motor Designed for 400-Cycle Current

The use of 400-cycle current by the military and industry for many types of servo mechanisms and in communications systems brought about the design and manufacture of the illustrated synchronous timing motor.

The motor is used in time delay relays, elapsed time indicators, potentiometer controls, and sequence, interval and repeat cycle timers. Many other special timers have been or are being developed to utilize this motor.



Synchronous timing motor.—Courtesy Haydon Mfg. Co., Inc., Torrington, Conn.

Only frequency control is necessary to insure accurate timing since the motor is not affected by variations in temperature, altitude, supply voltage and load within the operational limits of the motor itself.

Self-Starting Insured

The motor is essentially two phase with two coils, cores and interlacing field pieces. To insure self-starting, a capacitor is put in series with one coil, thus giving this coil a leading flux effect.

Copper Alloys Widely Used

As in all electric motors, copper and copper-base alloys are widely used not only for their electrical characteristics but for corrosion resistance and ease of working or machining.

The motor cover is cartridge brass (70% copper and 30% zinc) which can be readily worked, has good corrosion resistance and a tensile strength of 76,000 psi in the hard-drawn condition. The cover is cupped, drawn and trimmed, then stamped with the company name and other information.

Since shading rings must have high electrical conductivity, electrolytic tough pitch copper 99.9% pure is used because of its 98-100% conductivity.

Self-Lubricating Bearings

Rotor bearings are of graphite bronze, which was selected for its self-lubricating properties. However, for the output bearing where long life and strength is demanded under comparatively heavy loads, commercial bronze is the choice. This alloy contains 89.5% copper, 8.5% zinc and 2% lead, which increases the machinability considerably. Many standard gear combinations are available to give varying output speeds depending on the timing involved.

Wheels of Clock Brass

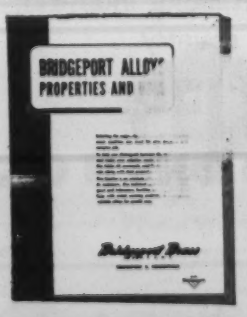
The wheels (gears) are made from clock brass (66% copper, 2% lead, and remainder zinc). The lead helps to eliminate burrs in machining the gear teeth and in blanking and piercing the wheels. Since the lead exists in the metal as small globules, some lubrication is obtained as the lead is burnished over the surface of the teeth while in operation.

Two alloys are used for the pinion gears depending on the load put on them.

Free cutting brass rod (61% copper, 3.4% lead and remainder zinc) permits clean drilling and machining of the pinions and gives long life under relatively light loads. When the loads are greater, a leaded phosphor bronze is utilized. (7496)

New Publication Available

"Bridgeport Alloys—Properties and Uses"—new 4-page folder designed to help the metalworking industry and other fields to distinguish between copper base alloys. Lists 65 commonly used Bridgeport alloys, their composition, properties, forms and typical uses. Write to our Sales Promotion Service.



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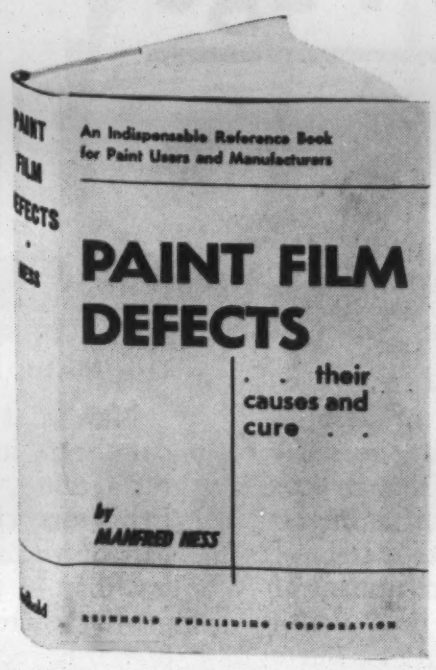

PAINT FILM DEFECTS
Their Causes and Cure
by Manfred Hess

This remarkably valuable book is the most complete compilation of paint defects and failures in existence. The contents are arranged as a reference work whereby Failure—Cause—Remedy appear under such sections as: Faults which develop during storage; Faults which develop during application; Failures developing shortly after application; and Defects of coatings on the finished objects when in use.

A glance at the 88-page index will impress you with the countless ways by which paintwork or lacquering may be spoiled despite the fact that the work is carried out with great care and skill or with the best materials! Yet there are the cracks, the discoloration, the stickiness, etc., etc. You can never exclude occasional failures, but you can reduce their number by discovering their causes. This book helps you locate the fault, even if due to several reasons, and shows how to correct it.

This first English edition is based on the standard German work but it has been largely rewritten and considerably enlarged. Many new sections connected with paint failures as they occur in typical damp climates, and important developments in the raw material side of the paint and varnish industry, have been added.

This unique book will save much time and money for paint users. It will also be of interest to paint manufacturers.

1951 561 pages illustrated $12.00

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The Editor's Page

Who's Nervous?

Certain organizations, in moments of desperation, call upon the guardian of this page to speak before their regular meetings. Even though this situation has existed for several years, it is impossible to stand before a group without some trace of nervousness. Recently, though, the chairman of such a technical meeting must have been just a trifle more nervous than the speaker. As he introduced me, he failed to identify me other than by name. Just to get even, I won't identify him.

Need a Medal?

News has recently come to light of a storehouse of supplies that should bring a sigh of relief from potential military heroes. In Philadelphia, so the report states, there is a warehouse filled with millions of medals, ranging from the Medal of Honor to World War II Victory Medals. An estimate places the metal tied up in medals at 776,400 lb—mostly copper and zinc. It looks as though we'll have to have a rerun of World War II if all the Victory Medals are to be used up. There are some 1,700,000 remaining in stock—with over 7,500,000 already distributed.

Eagle-Eyed Friend

There is nothing like an eagle-eyed friendly critic to keep an editor on the alert. One that I so classify is Wilmer Moore of Hoskins in Detroit. This sometime golf rival of mine has an understandable shyness in connection with the subject of nickel. Therefore, he pointed out to me that a recent news item on nickel, while true, could be misleading. The item pointed out that there would be a slight increase in nickel production next year. What wasn't said was that even with the increase from all sources, there will still be a continuing, acute shortage of nickel for all but the most essential users of that metal.

The Metal Show—in Retrospect

Now that my feet have recovered from the daily walk in the suburbs of Detroit covering the Metal Show, I can appraise that affair more calmly. Exhibitors claimed considerable interest on the part of visitors, although attendance seemed to be less than at many previous shows. It appeared to me that more heat treating equipment was on display this year than during any of the past eight shows. However, it seems to me that Metal Show is now a misnomer—it appears more accurately to be a Metal Working Show.

What Hotels!

By the way, where did they ever dig up some of the hotels to house Metal Show visitors in Detroit? One man we know still hasn't found anybody that can locate for him the hotel to which he was assigned. Not even the Detroit cab drivers knew.

Get-Rich-Quick Scheme

If I could only spare the time, I'd hurry right out and stake claims to the mineral rights under most of the main streets of the United States. What would I dig for? Why, for the millions of tons of high grade steel buried there in the form of street car tracks. An OPS premium on this scrap, plus the urgent need for scrap, should make recovery of such hidden treasure a financial and patriotic duty of every city and transit authority. It always has given me a peculiar feeling when I've seen shining steel rails disappear under the spewing of the pavers. Perhaps we'll learn our lesson soon and believe that there is some merit in saving our materials. Anyhow, let me join in the refrain and urge each and every one of you to dig up all the metal scrap you can and turn it in immediately.

T. C. Du Mond
Editor

Materials & Methods

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DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

DECEMBER 1951

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Magnesium, Aluminum and Steel Weights

Stiffness and Strength of Structural Metals

Materials & Methods Manual No. 77

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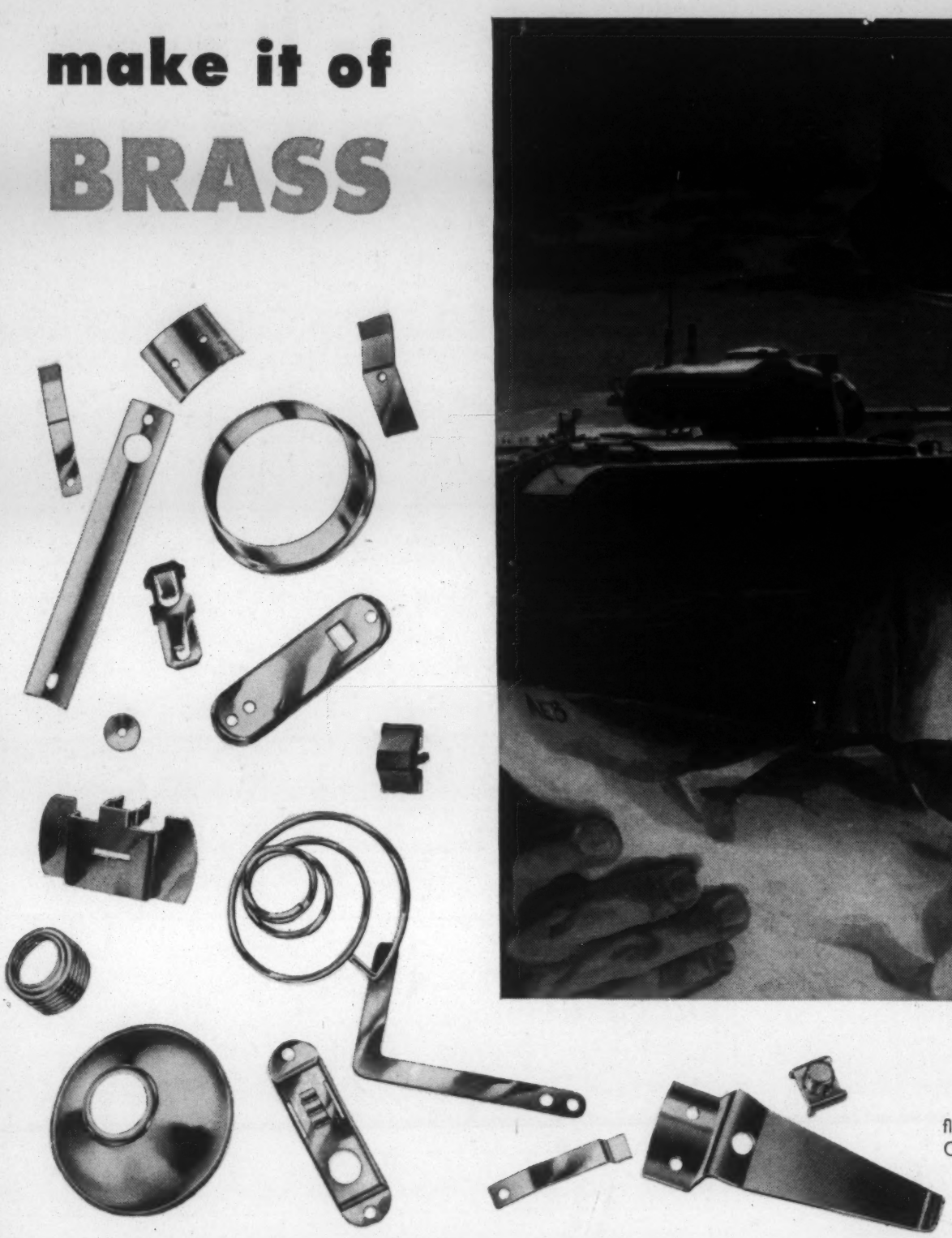
to turn a production problem into a **LIGHT** *subject—*

make it of BRASS



These eighteen copper alloy parts, illustrated approximately half-size, go into the military flashlight produced by The Niagara Searchlight Corporation of Buffalo, N. Y. Only copper alloys can provide the complete range of physical properties needed and still maintain low manufacturing cost.

If, like this military flashlight, your product consists of parts calling for certain physical properties . . . if it must be born of a streamlined manufacturing budget and still be an aristocrat in quality—then you'll find no metal more versatile than brass.

Although almost all of these 18 metal parts differ in their function, copper alloys supply the required properties — high electrical conductivity, resilience, excellence as a plating base, strength, immunity to rust and resistance to corrosion. And to all these properties, singly or in combination, add the characteristic that brass can be fabricated more economically by more methods than any other metal.

With all these properties, brass has no equal for its usefulness as a manufacturing metal. Brass is the metal on which your designers, cost analysts, production men and sales department will be most likely to agree.

Our Technical Department will gladly suggest the copper alloy best suited to your product and manufacturing methods. Just write to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

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These ceramic-coated exhaust parts for Ryan Aeronautical Company are entering the furnace on Inconel points for firing at 1850°F. at plant of the California Metal Enameling Co., Los Angeles, Calif.

Ceramic protected aircraft parts fired at 1850°F. on Inconel burning tools

It takes temperatures up to 1850°F. to fire the protective ceramic coatings on aircraft exhaust parts.

Naturally the burning tools used in such an operation have to be tough. Time after time they are sent into the furnace to take a high temperature beating that few materials can hold up under . . . for any length of time.

But the tools are no problem to California Metal Enameling Company who fire the parts for Ryan Aeronautical Company in Los Angeles.

That's because they use Inconel!

They find Inconel extremely resistant to corrosion and oxidation at temperatures up to 2200°F. They also find that Inconel's high hot strength permits lighter weight fixtures with correspondingly lower fuel costs.

And as a result of their findings, practically all the burning tools and hooks in their plant are made of Inconel. *And they have worked perfectly since the first firing!*

Right now, Inconel is hard to get because so much is being diverted to defense. But if you have a high-temperature metal problem in your operation, INCO's High Temperature Engineers will gladly help you search out a solution. Write today and ask them to send you a High Temperature Work Sheet on which you can easily outline your problem.

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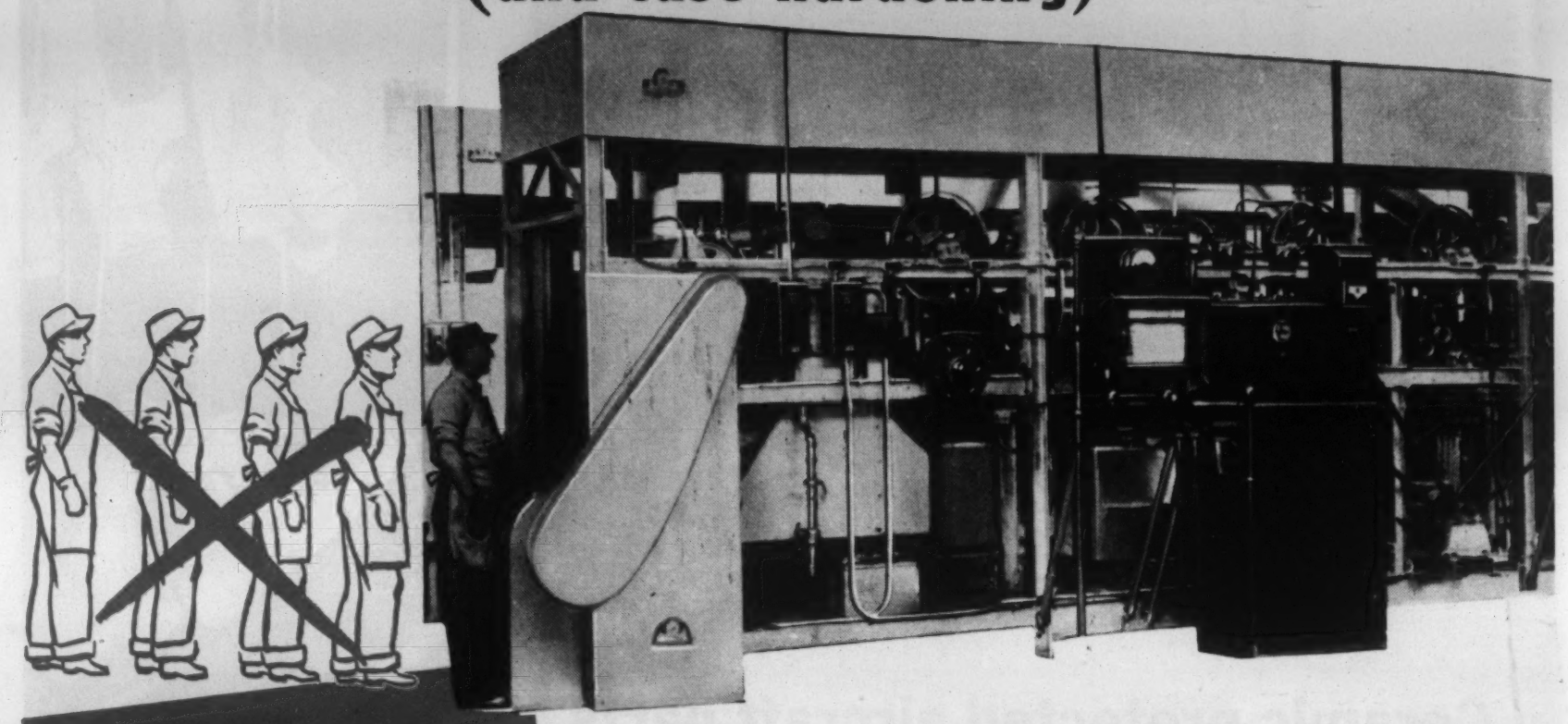

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... by these two mechanized lines using Ajax Salt Baths for carburizing compressor parts in plant of prominent manufacturer of electric refrigerators.

More economical . . . is the fastest method of producing a specified case depth—for example, a case of 0.040 in. can readily be produced in 2 hours . . . No boxes or retorts to pack and unpack or to heat as dead loads.

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The more you can increase its capacity . . . the more you can speed it up . . . the easier you can make it to handle—the better. But it's even more important that you build it as strong, as dependable and as durable as possible. Structural failures that can put it out of service must be reduced to the absolute minimum. *You must give it the stamina to stay on the job.*

You can do it with U·S·S HIGH STRENGTH STEELS

With high-strength U·S·S COR-TEN, U·S·S MAN-TEN and U·S·S TRI-TEN, equipment breakdowns that hamper operations and run up costs can be greatly reduced. With these famous "steels that do more" you can build maximum strength and toughness in vital parts ordinarily prone to failure. With them, high resistance to wear, fatigue, abrasion and impact can be incorporated. And if your equipment must operate in sub-zero temperatures or under unusually corrosive conditions, high resistance to these destructive forces can readily be secured.

In addition, these U·S·S High Strength Steels—because they have a yield point 50% higher than ordinary structural steel—can be used to materially increase the strength of parts without increasing their weight. Or they can be used in lighter sections without in any way diminishing strength or stamina. In the latter case, *substantial savings in steel will result*. This is important now, with steel in restricted supply.

Our engineers for 16 years have cooperated with manufacturers in applying U·S·S High Strength Steels to construction equipment famous for its reliability, long life and low maintenance cost. They will be glad to show you how these tougher, stronger, more durable steels can be applied to give your equipment the stamina to stay on the job.

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U·S·S TRI-TEN

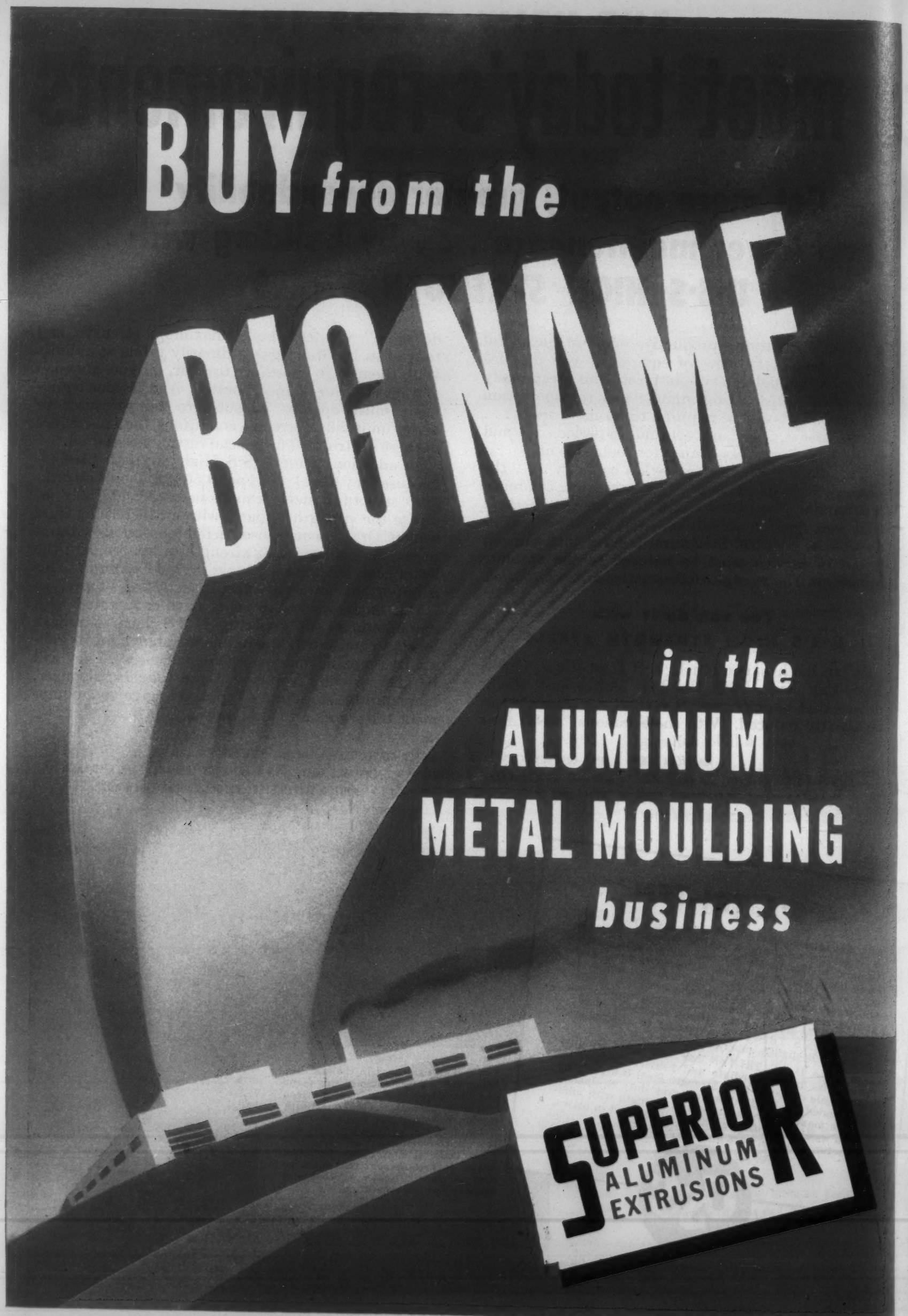
This manganese-nickel-copper steel has a yield point of 50,000 psi min, and a tensile strength of 70,000 psi min. in thicknesses ½" and under, with moderately lower values as thickness increases to a maximum of 4". It has superior toughness and ability to withstand shock at sub-zero temperatures. It has greater resistance to abrasion than structural carbon steel (ASTM A7) and its fatigue resistance is 50% higher. U·S·S TRI-TEN'S resistance to atmospheric corrosion is slightly superior to copper steel.

Because U·S·S TRI-TEN has very good welding properties in intermediate and heavier thicknesses, this grade of U·S·S High Strength Steel is highly recommended for application in heavy duty equipment where maximum ruggedness and strength with minimum weight are prime requisites. Produced in plates, structural shapes, bars and bar shapes.

USS TRADE MARK

U·S·S TRI-TEN, used in the stiff leg, boom and crowd handle of this giant Marion 45-cu. yd. shovel, assures maximum strength and toughness with minimum weight. TRI-TEN'S excellent weldability and its superior resistance to embrittlement in sub-zero temperatures make it first choice for such heavy duty equipment that must be able to perform under rigorous and extreme climatic conditions.

UNITED STATES STEEL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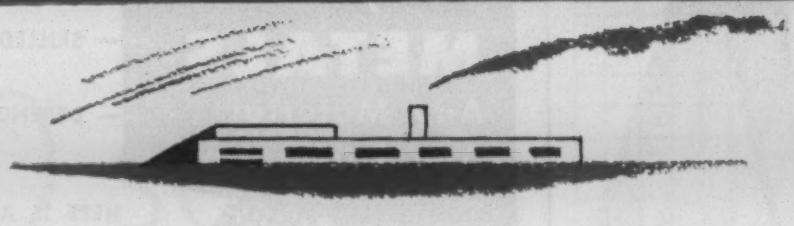

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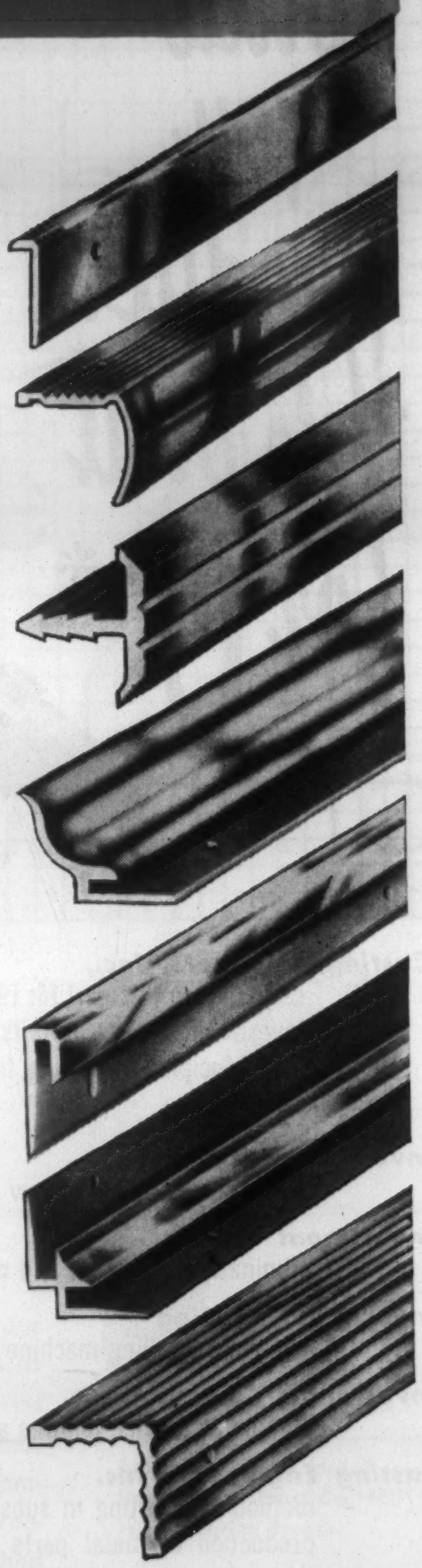
You profit when you do business with people who can give you what you want in moulding, in any shape, size or style. That's Youngstown Manufacturing, Inc.

You profit when you do business with specialists, men who concentrate on aluminum extrusions. They can give you the assistance you demand in your specific requirements.

You profit when you do business with a manufacturer who has the big facilities, the people who work in quantities.

You profit when you do business with a company which has pioneered in aluminum extrusions; who can interpret what you want and deliver when you want it.

That's Youngstown Manufacturing, Inc., the big name in the aluminum shape business . . . complete line, mass production facilities, specialists in aluminum extrusions. Prompt service.



TIE UP WITH THE STEADY SUPPLIER

● Stable and steady—that's the reputation which Youngstown Manufacturing, Inc., has built among distributors and dealers in their many years in the aluminum business. Youngstown Manufacturing, Inc., sells exclusively through distributor-dealer channels. If you are interested in doing business with a manufacturer who will give you the delivery, the service, the assistance you need as a distributor or dealer, write to Youngstown Manufacturing, Inc.

FINISHED MOULDINGS FOR YOUR PRODUCT

● Whatever you make to sell . . . dinette sets, doors, laboratory instruments, functional shapes, mechanical pencils, windows, soda fountains . . . Youngstown Manufacturing, Inc., can be your supplier of aluminum in any extruded shape for your product. Shapes of intricate design, or standard shapes, polished or finished to your specifications, ready for your assembly line, is the business of Youngstown Manufacturing, Inc., the big name in the aluminum moulding business. Engineering and designing service available. Write about your requirements.

YOUNGSTOWN MANUFACTURING, INC.

66-76 South Prospect Street
Youngstown 6, Ohio

SUPERIOR METAL MOULDINGS

Could you produce this part for 19¢ *

This pawl is a vital part of a Bazooka

* in tool steel to maximum tolerances of ±.003"

Casting Engineers, Inc.,
can produce this part for 19c because our method of investment casting permits the use of mass production principles by casting, in this instance, 108 pieces at one time.

Investment Casting
eliminates handling of raw material stock.

Investment Casting
eliminates drill press and operator.

Investment Casting
eliminates milling machine and operator.

Investment Casting
eliminates service failures and spoilage.

Casting Engineers', Inc.
method is resulting in substantial economies in the production of metal parts of all kinds, especially those of intricate design or where materials used make it impossible or costly to machine.

ENGINEERED PRECISION CASTINGS

For a guide to important savings, send today for new booklet "Cost Reductions Through Investment Castings"

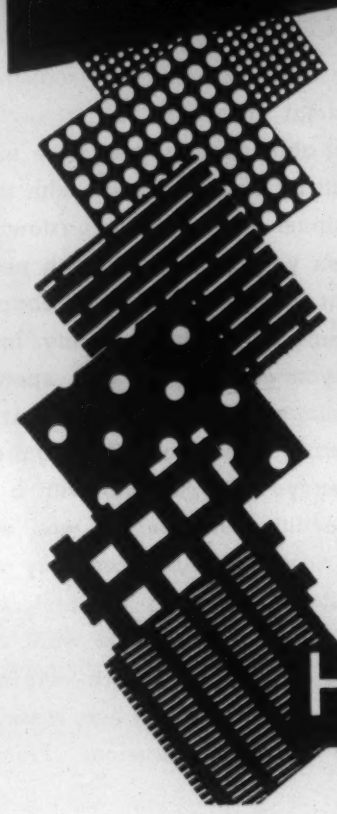
CASTING ENGINEERS

INCORPORATED

2323 BOSWORTH AVENUE, CHICAGO 14, ILL.

Perforated **METALS**
Any Material
Any Perforation

— WIDE RANGE OF PATTERNS
— SKILLED WORKMANSHIP
— DEPENDABLE ACCURACY



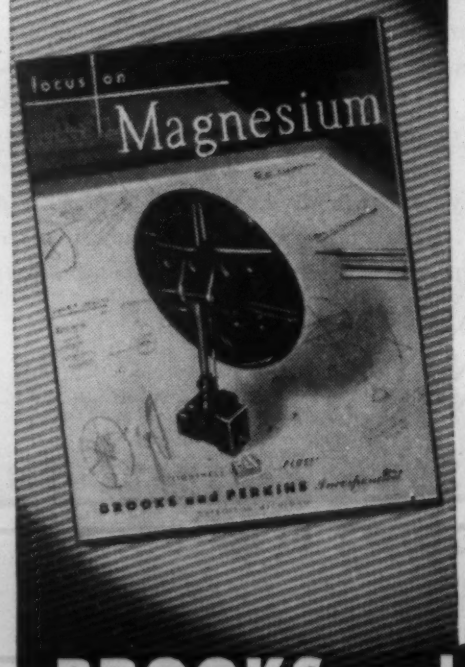
HERE IS A BACKLOG of perforating skill and experience that's been growing for over 68 years. **Materials?** Any available metal can be perforated—or the non-metals, such as Plastics, Plywood, Rubber and Fabrikoids—practically any sheet, plate or coil material. **Perforations?** A selection without limit, from holes .020" in diameter up to 9" (slots from .006" wide). And from tissue paper or foil thicknesses, you can go up to 1" steel . . . such are the possibilities at H & K. Your problems—large or small—are readily solved at "Perforating Headquarters." Write for complete information.

ALSO REMEMBER—H & K
Standardized Guard Parts for the safe enclosure of gears, motors, belts and other dangerous moving parts.

The Harrington & King PERFORATING CO.

5671 FILLMORE ST., CHICAGO 44, ILL.
114 LIBERTY ST., NEW YORK 6, N. Y.

When, Where, and Why MIGHT YOU BE SPECIFYING MAGNESIUM?



● **Worth knowing *all* about: MAGNESIUM, the ultimate in lightness. B & P's years of experience can be helpful to you . . . This little folder has a table of characteristics of Magnesium alloys; design data; pictures of products produced in Magnesium by B & P. We'll be glad to mail you one.**

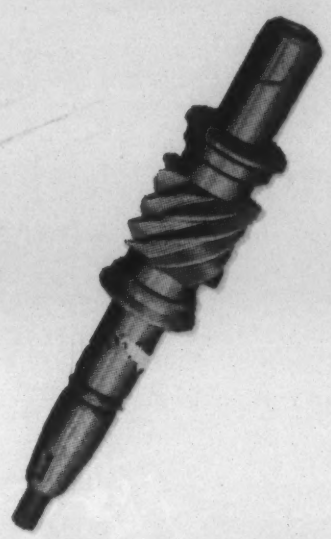
BROOKS and PERKINS

INCORPORATED

FABRICATORS OF MAGNESIUM

1950 WEST FORT • DETROIT 16, MICH.

MUELLER BRASS CO.

600 series a better bearing bronze 

containing no hard-to-get tin

If you use gears, connecting rods or other parts of bearing metal in your products, it will pay you to investigate Mueller Brass Co. "600" series, a forgeable bronze that *contains no critical tin.* This bearing metal outperforms phosphor bronze and other bearing metals and will save you money in your applications. "600" series bearing metal can be forged into relatively complicated shapes and produces a forging of close-grained homogeneous structure impossible to get in a casting. The forged shape is closer to finished size than a casting and requires less machining. "600" series alloys have a low coefficient of friction, a tensile strength 2½ times greater than cast phosphor bronzes and a high resistance to corrosion. "600" has a 25 year record of outstanding performance on some of the toughest bearing applications. There is a "600" series alloy with the properties to fit your bearing metal needs . . . write today for further facts.

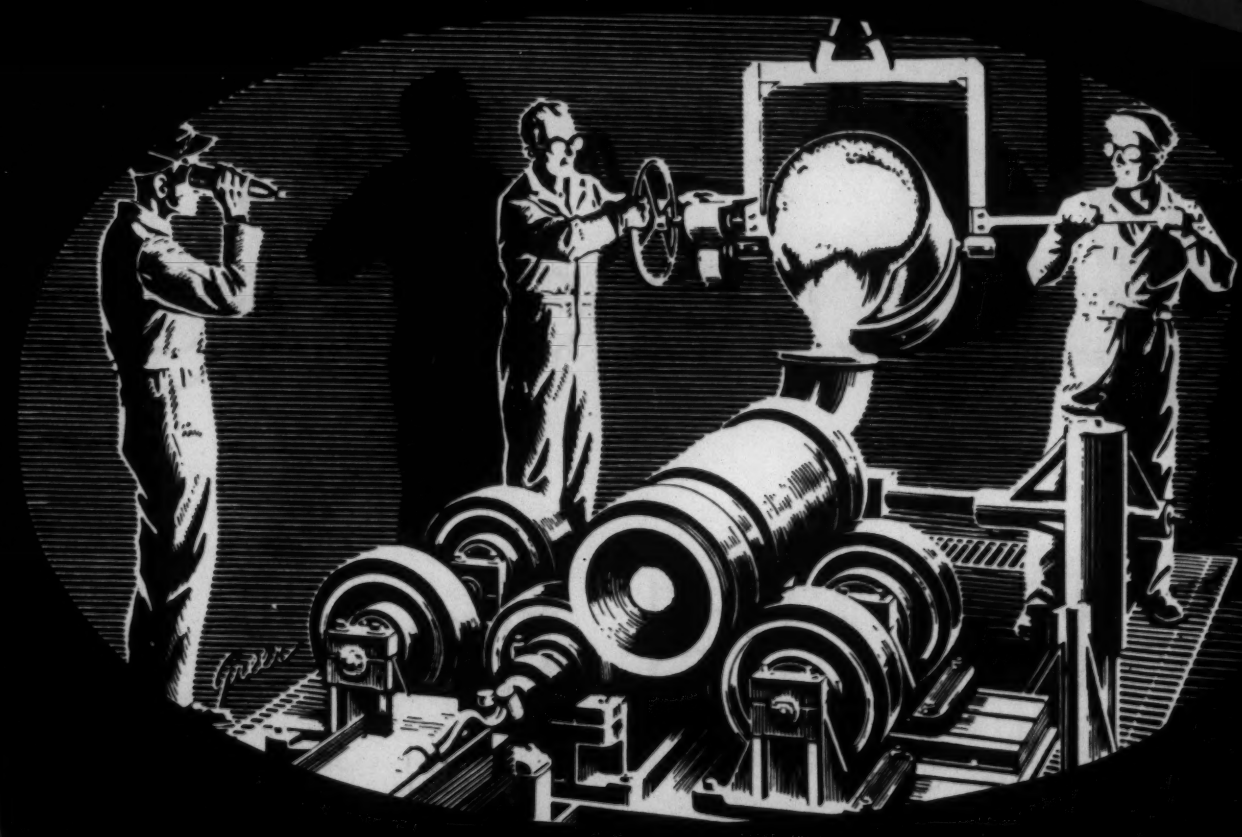
Four typical parts forged from Mueller Brass Co. "600" series Bearing Bronze.

MUELLER BRASS CO.

PORT HURON 20, MICHIGAN

64

family



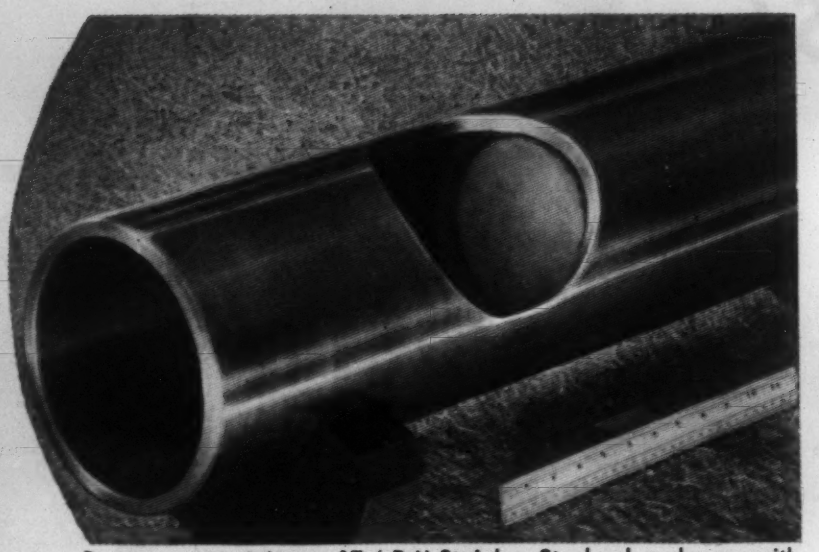
SPECIAL PRODUCTS DIVISION

U. S. PIPE AND FOUNDRY CO., BURLINGTON, NEW JERSEY

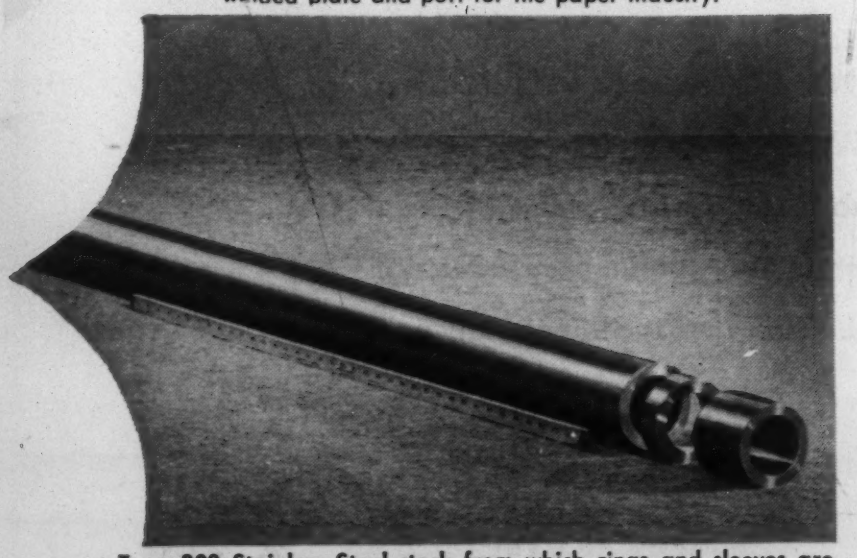
AMERICA'S LARGEST PRODUCER OF CENTRIFUGALLY CAST FERROUS METAL PRODUCTS IN TUBULAR FORM

portrait!

METAL MOLD CENTRIFUGAL CASTING SPELLS ECONOMY AND EFFICIENCY FOR WIDENING GROUP OF STAINLESS STEEL PRODUCTS



Finisn machined Armco 17-4 P H Stainless Steel valve plunger with welded plate and port for the paper industry.



Type 303 Stainless Steel stock from which rings and sleeves are fabricated for many industrial and defense applications.

Rough machined Type 316 Stainless Steel bowl casting for the food and processing industries.

Pictured here are a few of the many stainless steel products now included in the rapidly increasing family of products centrifugally cast for industry by our new metal mold process.

This method offers many specific advantages. For one, centrifugally cast stainless steel cylindrical sections, formed by pouring molten metal into rapidly spinning, refractory-coated permanent metal molds represent the ultimate in casting quality, imparting a fine, dense grain structure, unusually free from conventional casting defects.

You may find that your stainless steel product can be cast more advantageously by this versatile process. Our engineers will be glad to answer any of your questions.

SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—4" to 30"

Wall Thickness—⅜" and up

Length—Up to 14' in the "as-cast" condition

Types of Stainless Cast—All standard AISI and ACI grades of ferritic and austenitic stainless, plus "Special" types

CHECK THESE ADVANTAGES FOR YOUR CYLINDRICALLY-SHAPED PRODUCTS:

- Reduced Processing Time and Increased Production.
- Minimum Scrap Loss.
- Design of parts to suit the specific job requirement by selecting the correct alloy — not the next best available alternate.
- Conservation of critical metals and alloys — especially on tubular parts now produced from solid sections.

Could you use some expert advice on the right fabric for **your** special needs? Want a new fabric developed for a particular purpose — or an existing fabric adapted for a new application? We'll be glad to help. Over half a century of experience in industrial fabric production has helped develop the skill and facilities it takes to solve such problems.

AT YOUR SERVICE — Mt. Vernon-Woodberry Mill's staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.

STANDARD FABRICS

Wide, Sail and Army Duck
Double and Single Filling
Hose-Belting and Shoe Duck
Filter Cloths
Dryer Felts
Narrow and Wide Drills
Twills

FABRICS BUILT TO SPECIFICATIONS
For Calendering, Laminating and Other Industrial applications.

CHECKING COEFFICIENT OF VARIATION And Average Factor Of Quality On Evenness In Roving With Belger Tester. One of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products.

Mt. Vernon **TURNER HALSEY** COMPANY *Selling Agents* 40 WORTH ST. · NEW YORK *Woodberry Mills*

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BARRETT* PHENOLIC RESINS

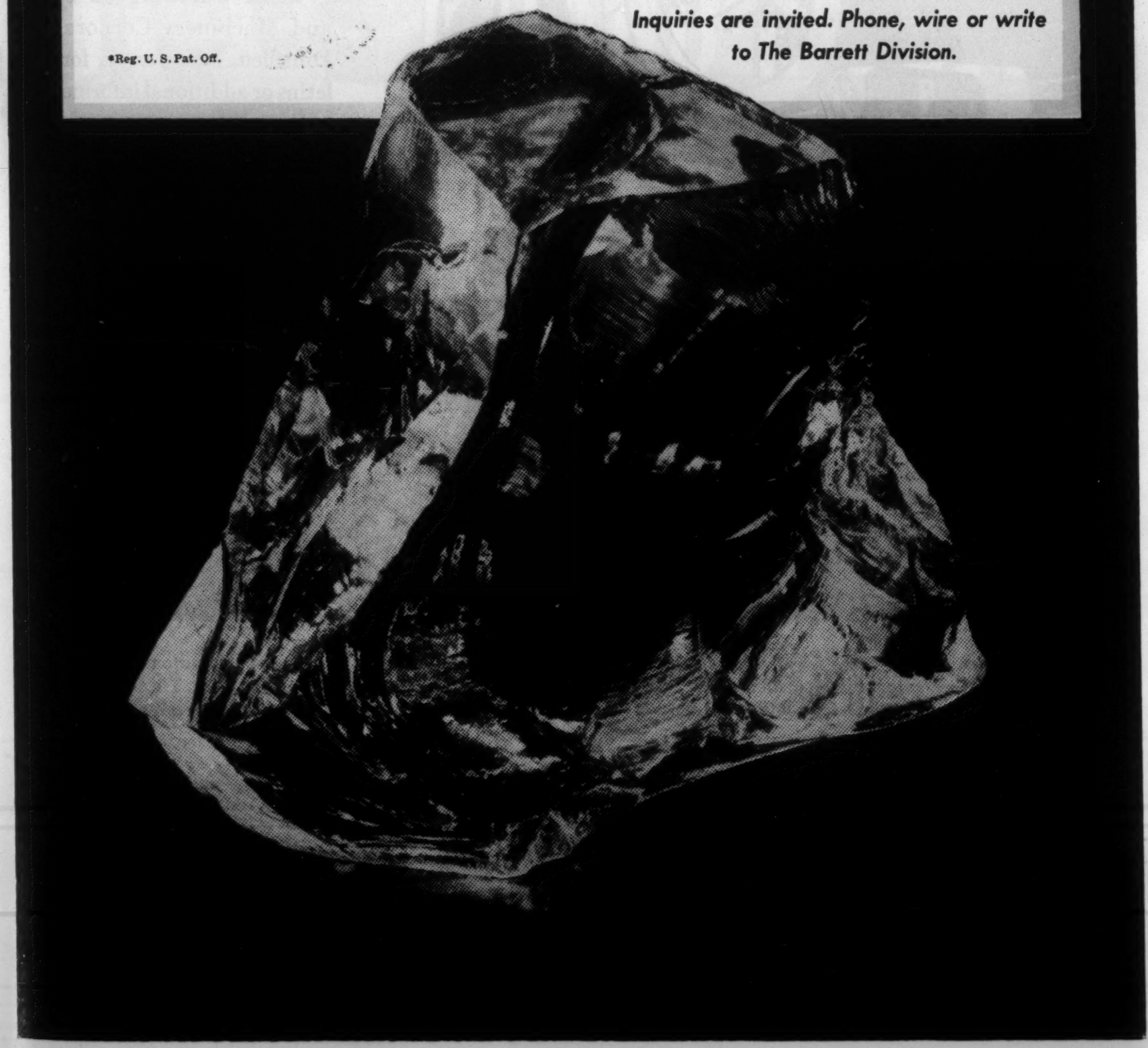
1. Liquid water-soluble resins
2. Laminating varnishes
3. Bonding resins for thermal insulation
4. Powdered resins for molding and miscellaneous uses
5. Friction resins
6. Bulk, lump and chip resin

Barrett*

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

Inquiries are invited. Phone, wire or write to The Barrett Division.

*Reg. U. S. Pat. Off.



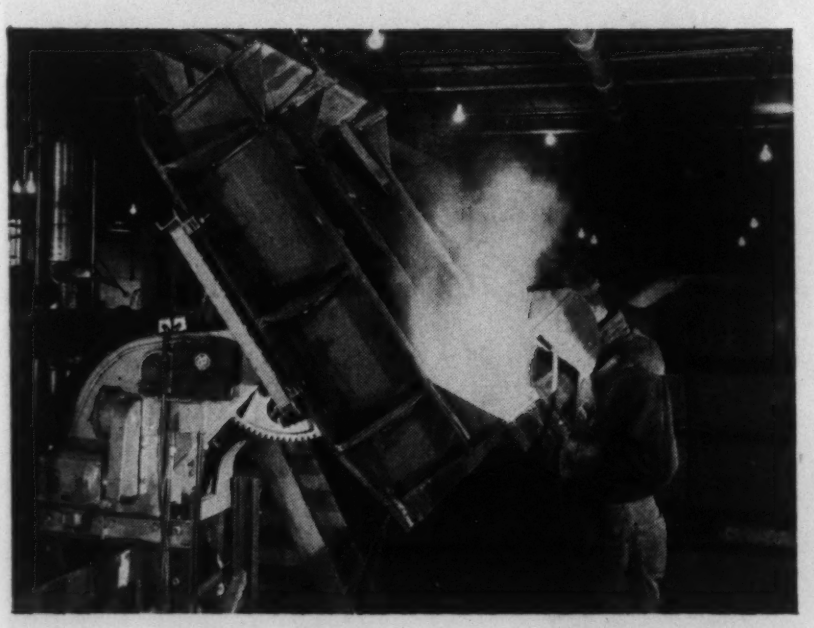
Give your welder a chance to be proud of his footage!

It's *waste welding time* when welders have to climb over, prop up or flop the work piece to get at the different seams.

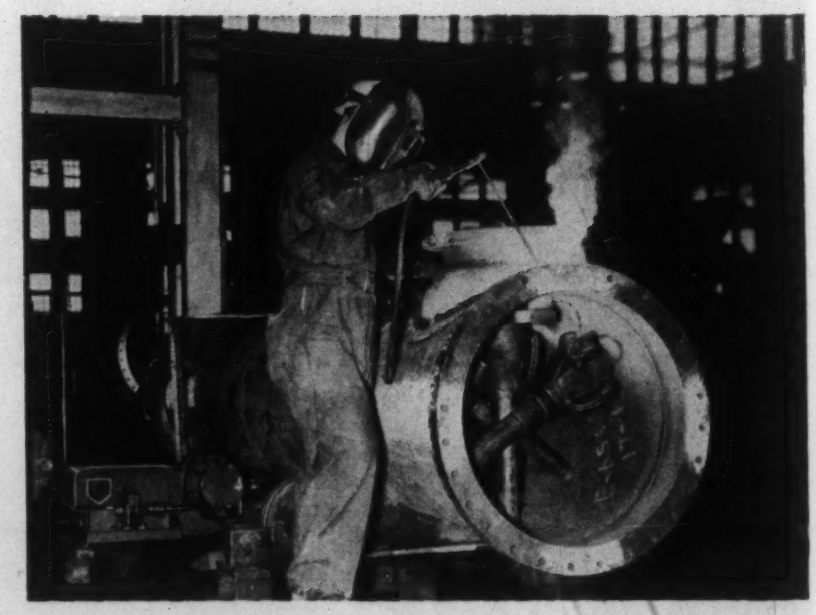
It's *all arc-time* when Worthington-Ransome Turning Rolls and Welding Positioners are used. All welds can be tilted or turned into position—without delay—for continuous downhand welding.

Result—up to 50% more footage, *better* welds (using higher current and heavier rods), less welding rod waste.

Write Worthington Pump and Machinery Corporation, Dunellen, New Jersey, for bulletins or additional information.



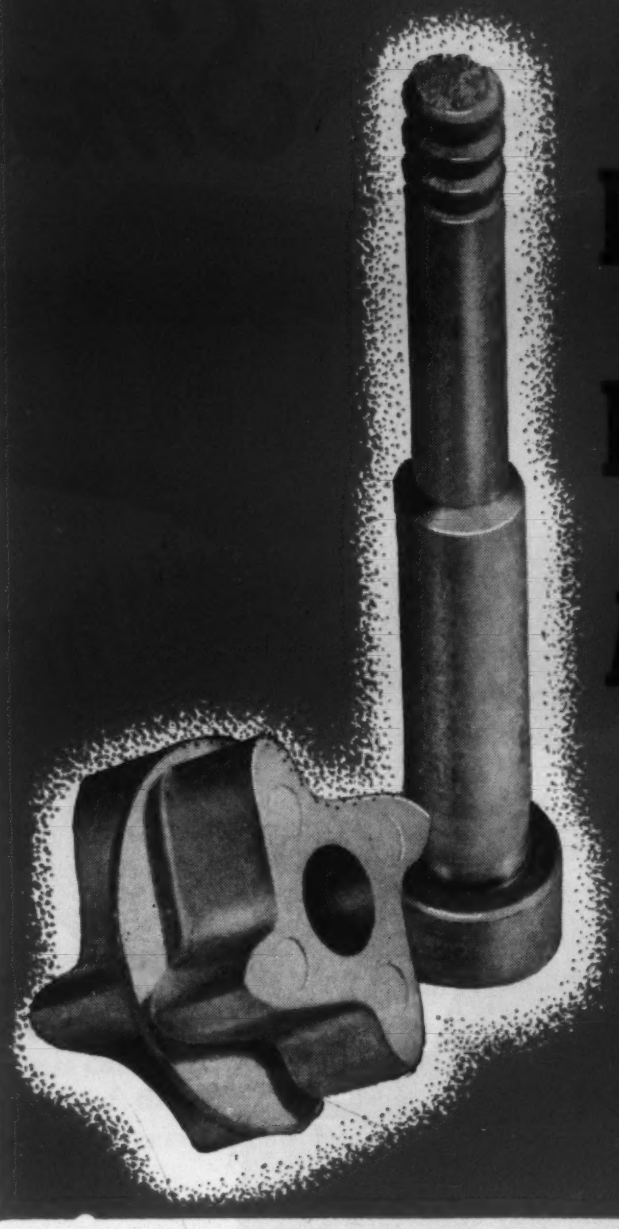
With one set-up, work piece may be tilted and rotated for either automatic or manual welding. Welding Positioner capacities from 100 lb to 30 tons.



Production goes up on manual or automatic welding, whether repetitive or job work. Turning Rolls from 3 to 150 tons, stationary or self-propelled.

WORTHINGTON

Y1-1



Life of This Tool Increased 17 TIMES After Treatment with HARD'N'TUFF

The die cast zinc rotor shown (left) is subjected to a burnishing operation which removes .02 inches of stock. The tool used (right) normally produced from high speed and hard chrome steels was able to finish only 20,000 to 30,000 pieces before refinishing.

Because of alloy steel shortages and in an attempt to bring about an efficient increase in production the tool was cut from cold rolled steel and treated with HARD'N'TUFF. The user says: "It finally wore out after 500,000 pieces. It held its size all the time it was in use. Previous tools of high speed and hard chrome plate steel lasted approximately 20,000 or 30,000 pieces. What better recommendation could I give your material?"

Here is real proof that HARD'N'TUFF, the steel hardening compound that provides fast effective three-way action;—carburizing, nitriding, chromizing—can solve many part hardening problems.

The metallurgical effect of the action of HARD'N'TUFF provides structural and chemical changes which raise the Quality properties of the low carbon mild steels.

Easy to use—heat the part, dip and roll in the compound; HARD'N'TUFF is non-toxic and can be used on all types of tools, drills, dies, cams, bits—wherever maximum toughness and wear resistance are required. Write for our folder "How to Use HARD'N'TUFF."

Our Guarantee

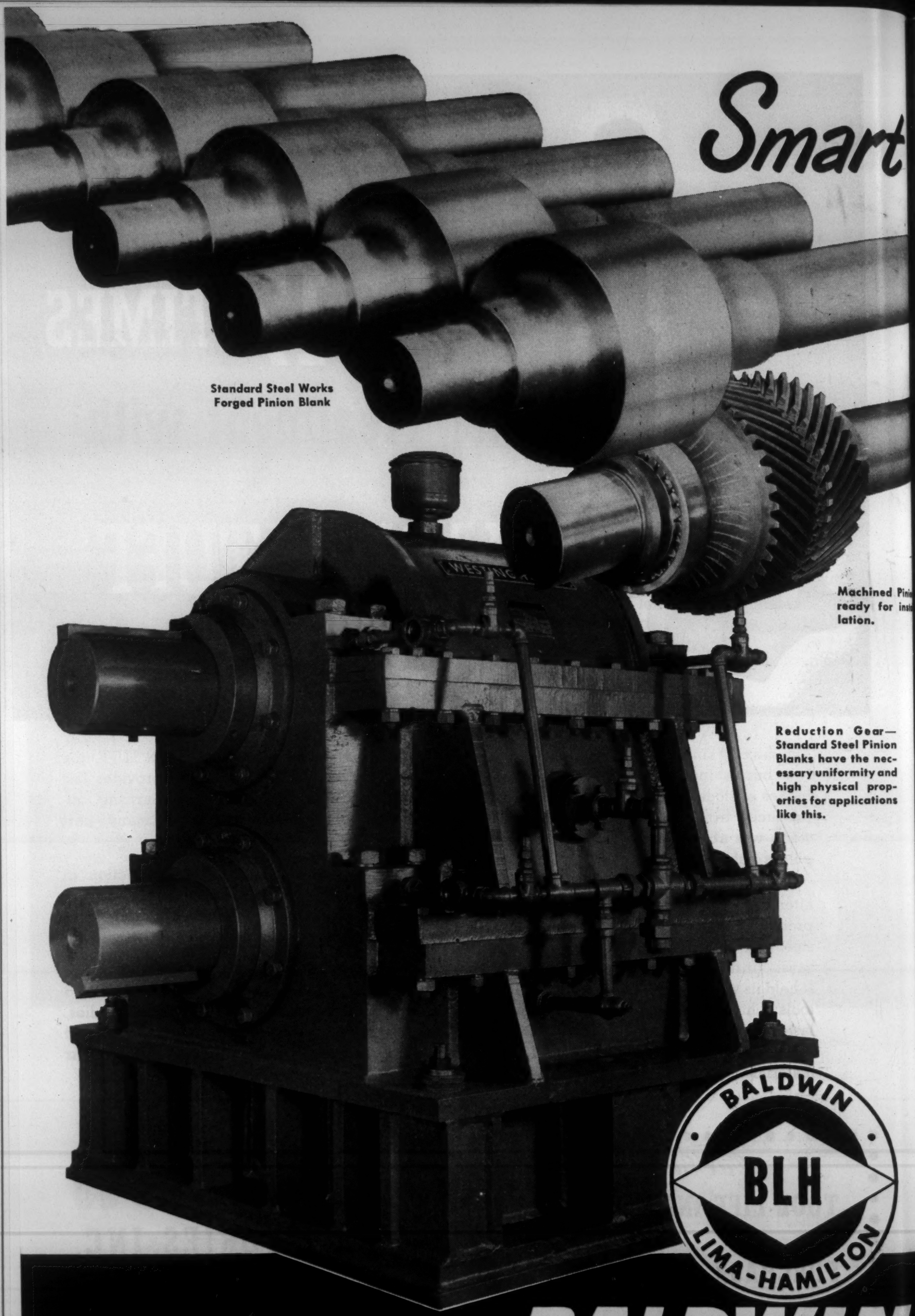
TOOL LIFE INCREASED 300%

or

PURCHASE PRICE REFUNDED

DOUGHTY LABORATORIES, INC.

500 FIFTH AVENUE • NEW YORK, N. Y.


Smart
Standard Steel Works
Forged Pinion Blank
Machined Pini
ready for inst
lation.
Reduction Gear—
Standard Steel Pinion
Blanks have the nec-
essary uniformity and
high physical prop-
erties for applications
like this.

BALDWIN

t operators cut their teeth on

STANDARD STEEL WORKS

forged pinion blanks

The high cost of machining a stub axle pinion like this makes it imperative to *start* with a blank that is free from flaws and completely uniform in structure.

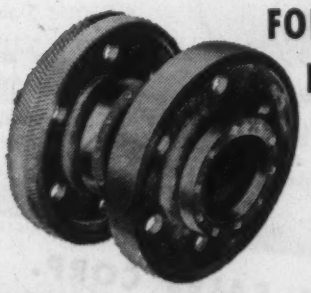
That's why these Standard Steel Works blanks are made with such particular care. They start with steel produced in Standard's own open hearth furnaces, where the most rigid control of analysis can be consistently maintained. Forging, on one of the battery of presses or hammers, develops superior physical properties, and refines the grain structure. Heat treating in special furnaces relieves strains, and adds an important plus to service qualities. Close dimensional tolerances reduce machining time and waste.

It is always well to remember that a gear can't be any better than the blank . . . and that getting a better blank is the surest way to assure minimum machining and maximum service. You'll find Standard an ideal supplier: big enough to handle the most particular jobs, small enough to make every job a matter of personal concern.

ALSO . . .

FORGED WELDLESS RINGS FOR RING GEARS

Uniform structure permits precision machining, assures uniform strength. No welded areas to affect tooth physical properties or finish.

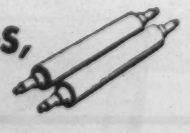


FORGED BLANKS FOR GEARS

Pressed die forgings for gear blanks provide the strength, toughness needed in heavy duty service. Conformity to design tolerances saves machining.

NOTICE: DESIGN AND PURCHASING DEPARTMENTS—Standard is equipped to supply pinion blanks in any size that can be worked under a hammer . . . weldless rings up to 12 feet diameter . . . and pressed die forgings up to 50 inches diameter. Make a note to let us quote on your requirements.

STANDARDIZE ON STANDARD for

GEAR BLANKS, STEEL CASTINGS, FORGINGS, 

WELDLESS RINGS, FLANGES

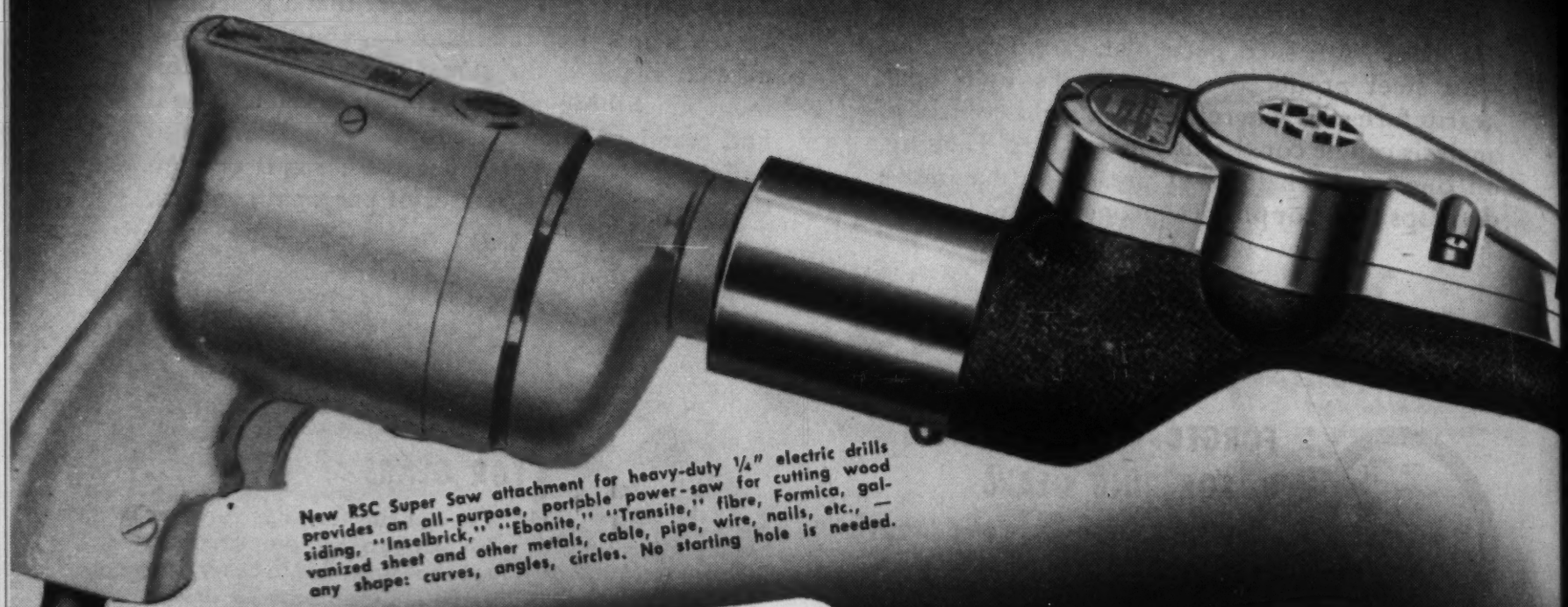
STANDARD STEEL WORKS DIVISION

Burnham, Mifflin County, Pennsylvania

· LIMA · HAMILTON

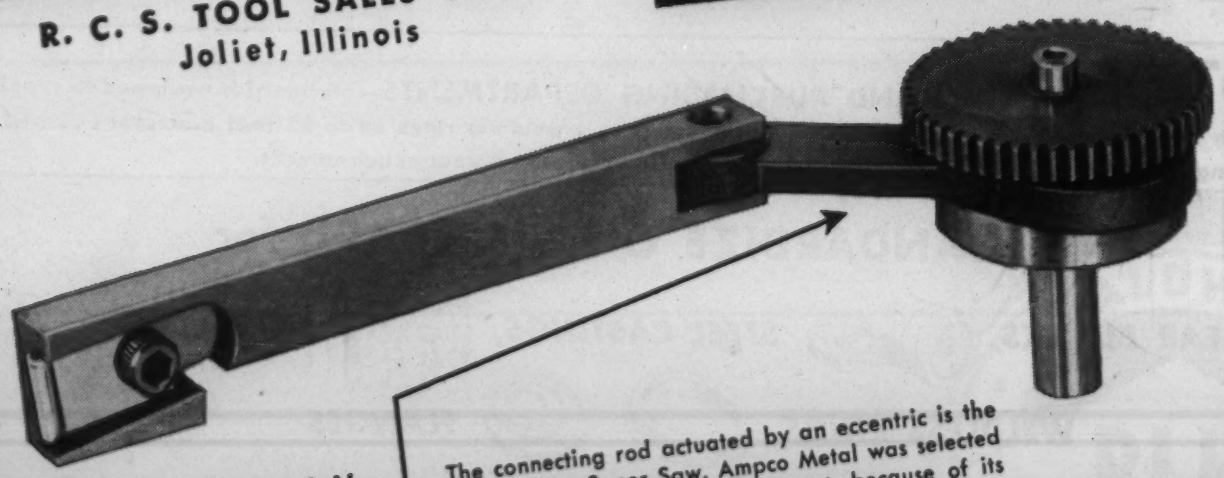
FIGHT WEAR

...in both Product and Plant



New RSC Super Saw attachment for heavy-duty 1/4" electric drills provides an all-purpose, portable power-saw for cutting wood siding, "Inselbrick," "Ebonite," "Transite," fibre, Formica, galvanized sheet and other metals, cable, pipe, wire, nails, etc., — any shape: curves, angles, circles. No starting hole is needed.

R. C. S. TOOL SALES CORP.
Joliet, Illinois

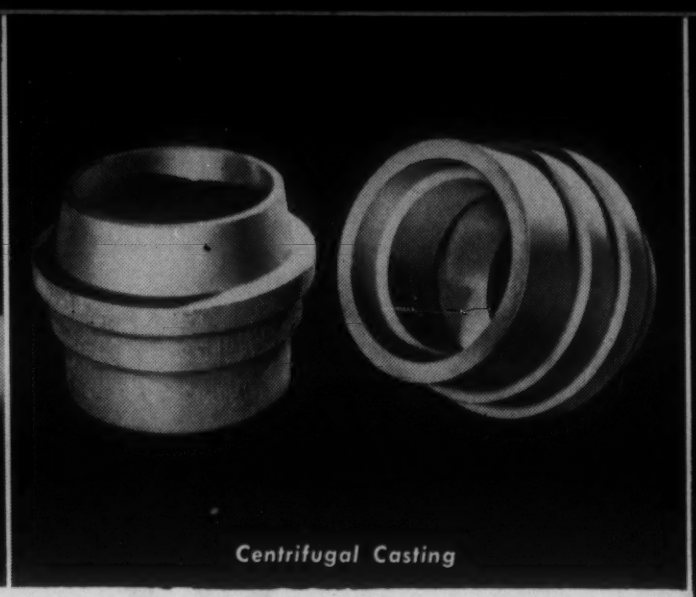


APPLICATION: The connecting rod actuated by an eccentric is the heart of the Super Saw. Ampco Metal was selected as the ideal material for this part, because of its high strength and ability to resist wear.

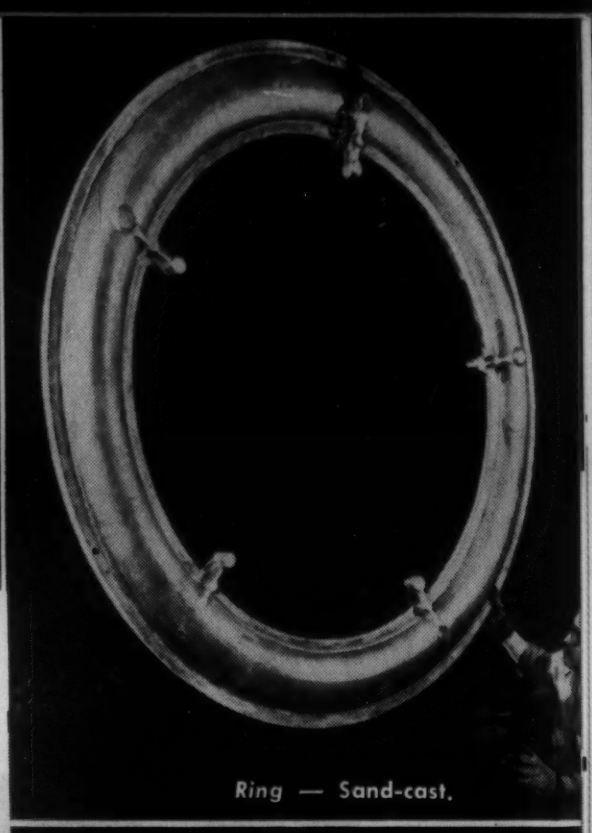
RESULT: The Super Saw can be used for continuous service, day in and day out.

IT'S PRODUCTION-WISE TO AMPCO-IZE!

Gear blank — Centrifugally-cast

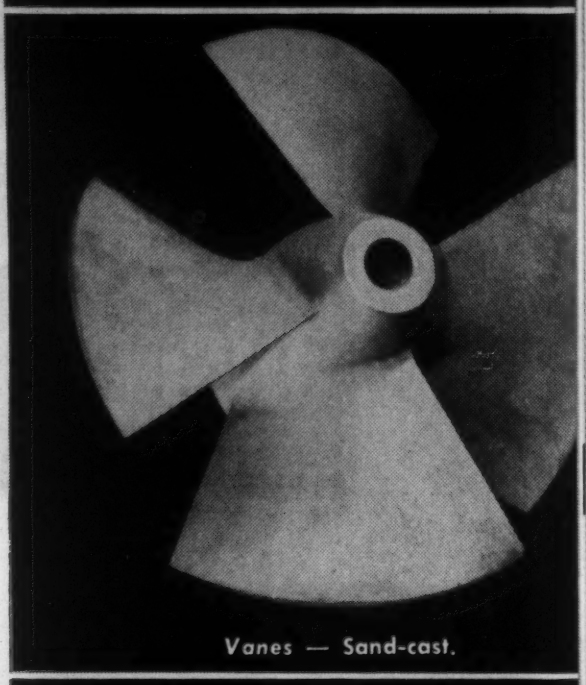


Centrifugal Casting



Ring — Sand-cast.

--with AMPCO* METAL



Vanes — Sand-cast.

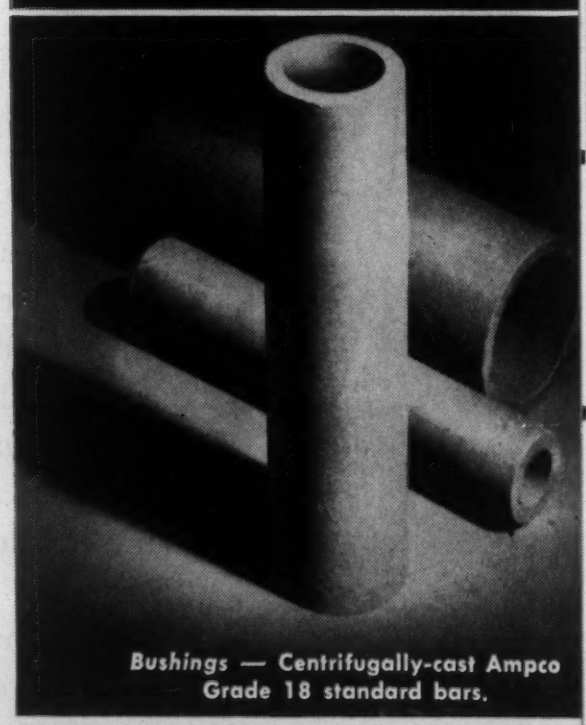
You can save plenty of money and eliminate lots of trouble with high-strength Ampco Metal.

You see, Ampco Metal resists wear — such types of wear as erosion, abrasion and cavitation-erosion. It also resists corrosion. That's why so many designers are putting Ampco Metal to work in their products. They want longer part life, better performance.

Moreover, thanks to its various hardness ranges, Ampco Metal is ideal for a wide variety of product services and plant-maintenance jobs. It resists both wear and squashing out — stands up under the heaviest kind of service.

And Ampco Metal is easy to use. It's available in bars, sheet, plate, tubing, sand and centrifugal castings, forgings, wire and welding electrodes — practically any form you want. When extra performance life is needed both in manufactured products and in production, specify Ampco Metal. Consult your nearest Ampco field engineer or send coupon for further information.

*Reg. U. S. Pat. Off., Ampco Metal, Inc.



Bushings — Centrifugally-cast Ampco Grade 18 standard bars.

Tear out this coupon and mail today!

Ampco Metal, Inc.
Milwaukee 46, Wisconsin
West Coast Plant
Burbank, California

AMPCO®

AMPCO METAL, INC., Dept. MA-12, Milwaukee 46, Wisconsin

Send me your free Ampco Metal literature giving descriptions and general applications of Ampco Metal.

Name.....Title.....

Company.....

Company Address.....

City.....(.....) State.....

dag
DISPERSIONS®

Products bearing the registered trademark **"dag"** originate only with the Acheson Colloids Corporation, Port Huron, Michigan, or with Acheson Colloids Ltd., London, England. Acheson Colloids is the world's largest producer of colloidal graphite dispersions for the metalworking and electronic industries, and also supplies dispersed pigments to a large segment of the color-consuming trade. The trademarks "Oildag", "Aquadag", "Prodag", "Glydag", "Castordag", "Varnodag" and "Gredag" identify particular products of Acheson Colloids Corporation or its affiliates, and are duly registered in the United States and in other principal countries of the world.

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Acheson Colloids Corporation, Port Huron, Michigan

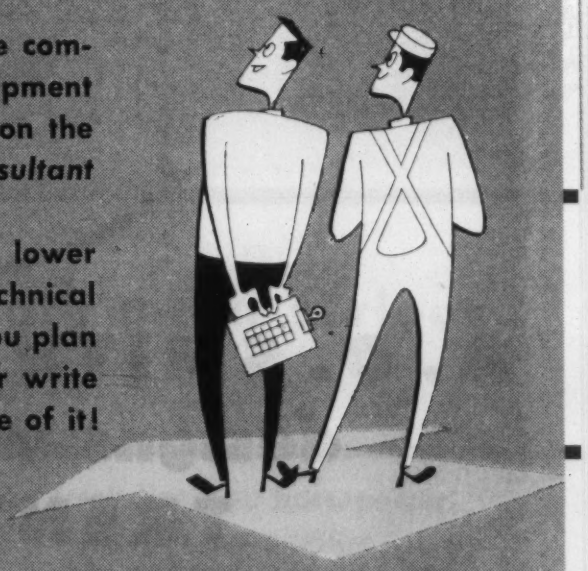
. . . also Acheson Colloids Limited, London, England

SILVALOY

An interesting example of top brazing efficiency with "*preformed*" rings!

SILVALOY preformed rings are used with utmost efficiency to braze the component parts of this unit for the General Electric Home Laundry Equipment Division. The Silvaloy preformed ring is quickly and easily positioned on the assembly and the complete unit is placed in an induction furnace — *the resultant joint is stronger than the metals joined!*

Silvaloy brazing is successfully helping to increase production and lower costs for thousands of manufacturers throughout the country. Our technical experts are always on call and will be glad to visit your plant to help you plan for best brazing results, lower costs and increased production. Call or write today. This useful service is offered without obligation. Take advantage of it!



SILVALOY SILVER BRAZING ALLOYS ARE SUPPLIED FROM STOCK THROUGH A RELIABLE DISTRIBUTOR IN YOUR AREA

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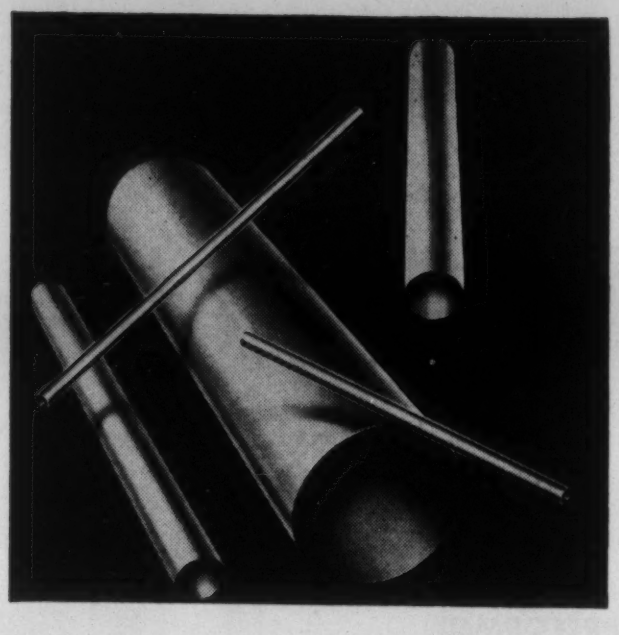
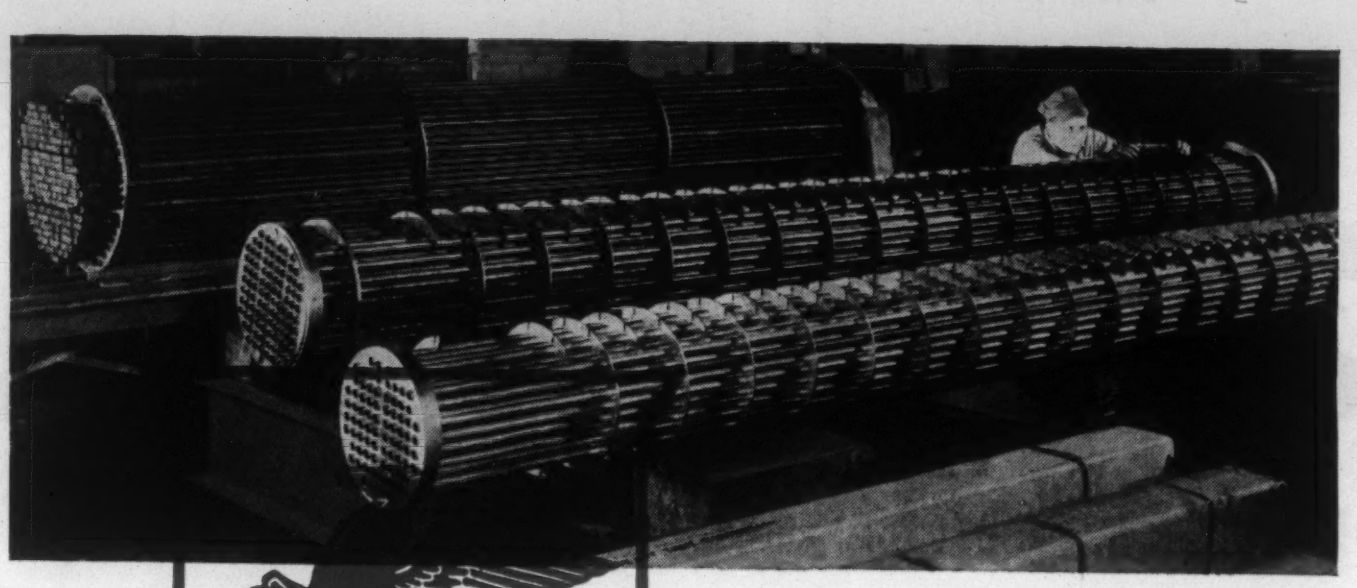




A. O. SMITH designs with TRENTWELD

When A. O. Smith, big name in steam and heat transfer equipment recently designed and built a heat exchanger unit for Socony-Vacuum — TRENTWELD Stainless Steel tubing was used throughout. This heat exchanger unit for use in the petroleum industry is another example of how TRENTWELD is preferred by designers for products where stainless steel tubing fits the bill.

And here's why: TRENTWELD is the product of tube specialists. That means you're assured uniform quality and specifications of manufacture that meet your most exacting needs. Then too, TRENTWELD is available in a full range of sizes—⅛" to 36" in diameter, in all grades and finishes. When the job requires stainless steel tubing, check with us.

TRENTWELD

STAINLESS STEEL TUBING

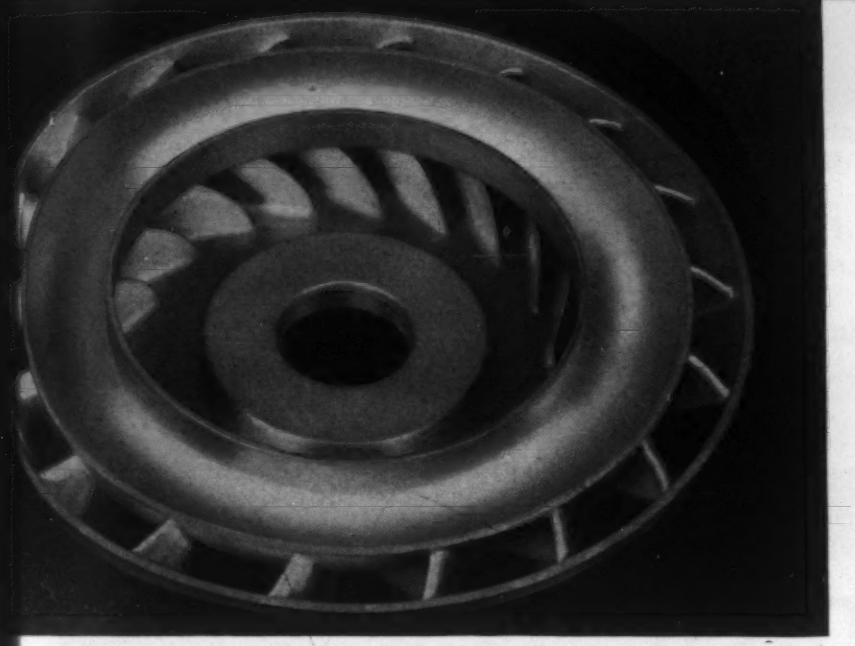
TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN

(Subsidiary of Crucible Steel Company of America)

Aluminum

Government regulations limit the use of aluminum for other than essential products. The facts presented here are to help you speed this essential work and get the most out of available metal.

Here Alcoa shows its latest design techniques and newest fabricated forms to help designers with Rearmament Problems.



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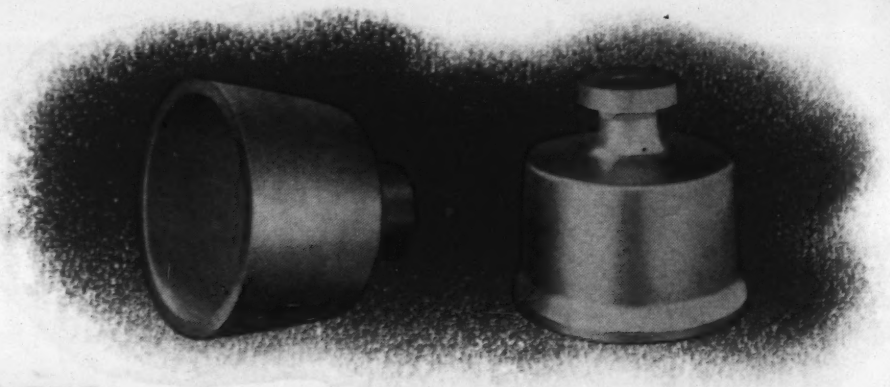

Aluminum Forgings

Their low density and high tensile strength merit serious consideration for high-speed rotating parts.

High tensile strength alone is not sufficient to guarantee satisfactory performance of high-speed rotating parts. In any rotating part, the magnitude of stresses is directly proportional to the density of the material used. Thus the stresses in a heavy metal part are about three times greater than the stresses in an aluminum part.

Density also influences the power required to accelerate or decelerate the part. For example, if it took 8.7 horsepower to accelerate a 12″ disc of aluminum from 0 to 10,000 rpm in 10 seconds, it would take 24.8 horsepower to accelerate a similar steel disc under the same conditions. If the speed were to be increased from 0 to 20,000 rpm in the same time interval, the aluminum disc would require 35 horsepower — the steel disc, 100 horsepower.

Rotational stresses increase in proportion to the square of the speed. For example, if centrifugal stresses in an aluminum disc were 10,000 psi, the stresses in an identical steel disc would be 30,000 psi. If the speed were doubled, the stress in the aluminum part would be 40,000 psi and 120,000 psi in the steel disc.

Because of Alcoa's wide experience in designing, forging and testing high-speed rotating parts, our specialists are exceptionally well-qualified to assist you in design and alloy selection. Basic design considerations are covered in Alcoa's 171-page book, "Designing for Alcoa Forgings". Write for your free copy.

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Finishing Aluminum

Vitreous Enamels provide abrasion and heat-resistant coatings for aluminum. They adhere well, are easy to apply.

The sequence of operations for applying vitreous enamels on aluminum are: cleaning, spraying, oven drying, fusing the enamel frit at high temperature.

Parts are cleaned by wiping with cloths saturated with solvents or by vapor degreasing. Inhibited alkaline cleaners should be used. The enamel frits are mixed with water or turpentine, sprayed on and oven-dried. Quick drying by oven is important because the free alkali in the enamel mixture will cause surface corrosion if parts are left to air-dry.

The enamel is fused at temperatures from 940 to 1000° F. This heat will partially anneal temper rolled sheet. The heat treatable alloys will be partially heat-treated, but not to a full degree, because quenching is not possible.

Vitreous enamels on aluminum have the advantages of excellent resistance to impact and thermal shock. Certain coatings have exceptional resistance to mild acids.

For complete information on finishing Alcoa Aluminum write to the address below.

Aluminum Die Castings

The difference between average and exceptional die castings is often the kind of design help the supplier offers. Consider Alcoa's qualifications.

Alcoa offers the kind of technical literature and personal design consultation that you would expect from the leader in the aluminum industry and a die-casting supplier of 34 years' experience.

The help of an Alcoa sales-engineer is instantly available through your local Alcoa sales office. He is thoroughly familiar with the methods of applying aluminum die castings to your particular design problems. He will accurately interpret your production problems to the casting experts

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at Alcoa's two modern die-casting plants. Often the simple suggestions that come from the close attention that Alcoa experts give your drawings can result in substantial savings and surprising increases in the performance of the finished product.

For the designer's technical library, Alcoa offers two books: "Designing for Alcoa Die Castings" — a 188-page book which covers all phases of design, machining and finishing. And "Machining Alcoa Aluminum" — a 67-page book which describes tooling, setup and machine speeds for all machining operations. Both books may be obtained through your local Alcoa sales office or by writing direct to the address given below.

Besides standard and special fasteners, Alcoa produces bushings, inserts for plastic and cast products, nozzles, valves, aircraft parts, electrical fittings, couplings, pipe and tube fittings.

Aluminum Fasteners

Alcoa supplements its complete line of standard fasteners with a broad range of special fasteners made to customer specification.

The capacity and versatility of Alcoa's headers, threaders, slotters, screw machines and related secondary equipment permit Alcoa to provide industry with thousands of standard and special fasteners made from aluminum alloys.

Alcoa's 63 years of aluminum experience can be counted on to provide the best obtainable products of this type. Engineering and design assistance are readily obtainable for analysis of your parts to determine where costs can be lowered and quality improved. Special tools and gauges are built in Alcoa's own toolrooms to facilitate production and inspection. And there is capacity in Alcoa's plants for reasonable delivery schedules to manufacturers with authorized production schedules and metal allotments.

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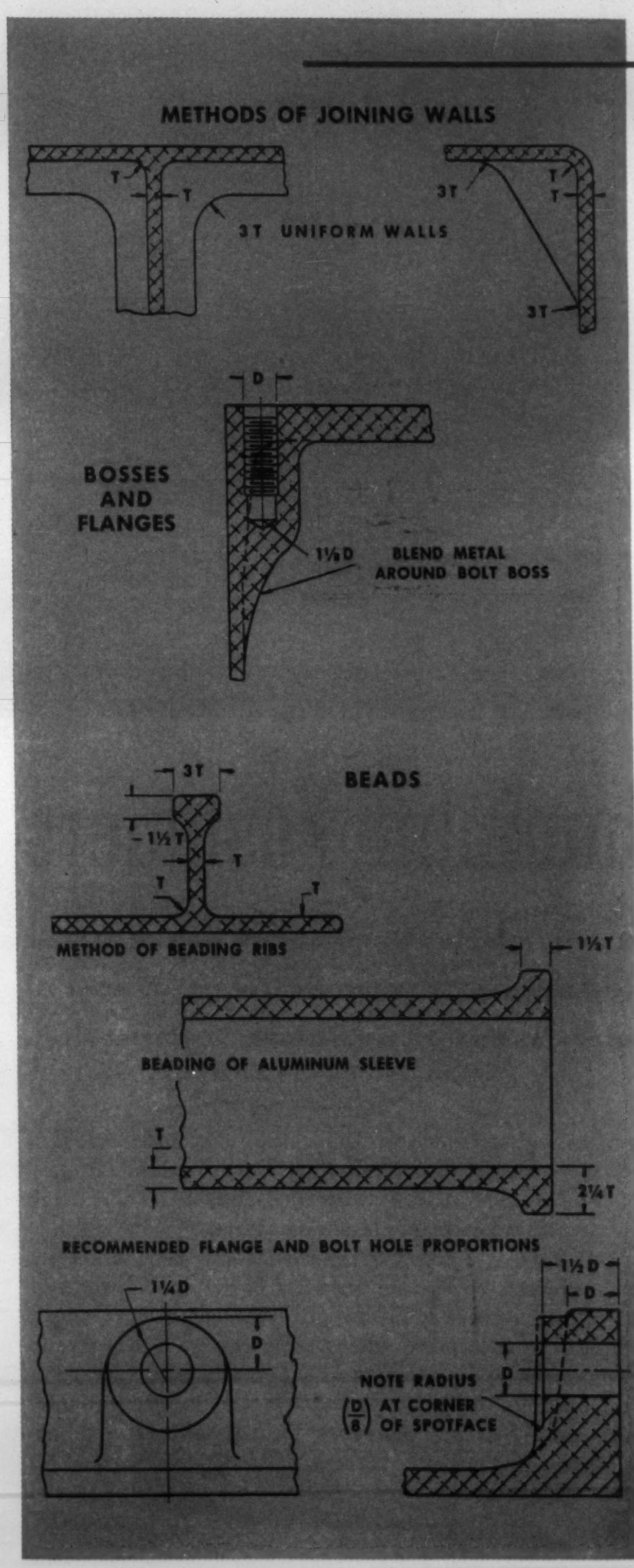
Aluminum Castings



Consider . . .

- **Alcoa as a source of supply . . .**
- **Modern foundries strategically located from coast to coast . . .**
- **63 years of light-metal experience.**

Following a few general rules to make sure of stronger, more uniform castings at minimum production cost.

SECTIONS — Try to design sections that are tapered in a way that facilitates flow of metal. If tapered sections are not practical, section thickness should be kept as uniform as possible. When it is necessary to join light and heavy sections, the thinner section should be gradually increased in thickness toward the junction.
Extremely thin sections should be avoided since these require high pouring temperatures resulting in poor metallurgical structure and loss of mechanical strength. Minimum section thickness in sand castings is usually $\frac{3}{16}$ inch; in permanent mold castings, $\frac{1}{8}$ inch.

FILLETS — Use generous fillets at all intersections as well as between ribs and bosses and their supporting sections. Fillets adjoining two sections of equal thickness should have a radius at least equal to the thickness. Filleting aids the flow of metal . . . minimizes shrinkage and cracking.

LOCATING POINTS — Plan locating points so they can be used by the foundry and pattern shop for checking dimensions, and by the machine shop in machining. Space these as far apart as the size of the casting permits and, preferably, all on the same side of the parting line so they will not be influenced by shifting of core, cope or drag.

INSERTS — If inserts of other metals are used in aluminum castings, be sure to provide sufficient metal around these inserts to protect the casting against stresses set up by different rates of expansion and shrinkage. Be sure, too, that strong mechanical bonds exist — slots, legs, dogs, and similar projections accomplish this.

PARTING LINES — Keep parting lines as straight as possible. The cost of producing castings with uneven parting lines is usually greater than the cost of redesign to straighten parting lines.

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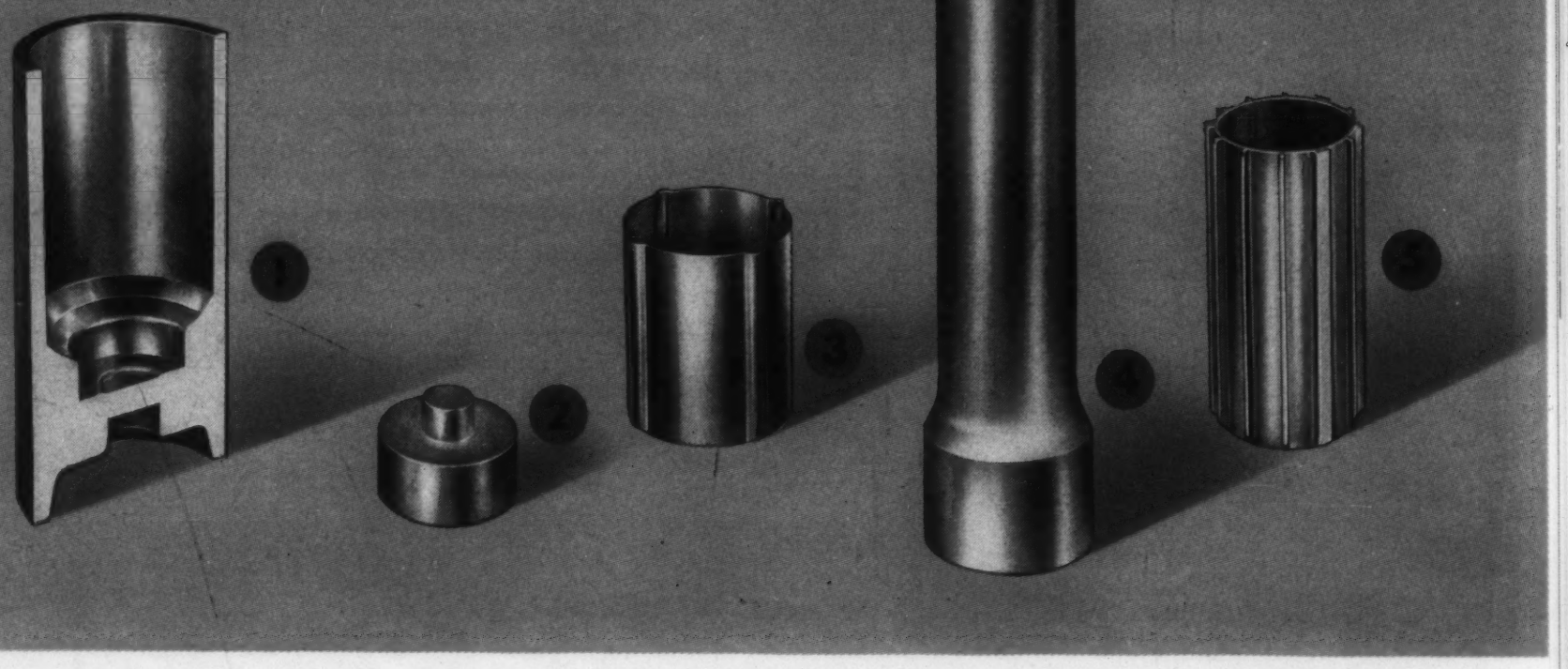
Aluminum Impact Extrusions

New and interesting forms of impact extrusions are being made by Alcoa. Those illustrated below suggest surprising savings in material and labor.



● **Shell Body** — This part shows the trend to higher strength alloys for impact extrusions. Extruding this heavy, massive part in 14S-T6 alloy is less expensive than machining the part from bar stock. Performance is improved due to the better grain structure inherent in impact extruded parts. And, produced as an impact extrusion, this part uses considerably less metal.

● **Motor End Cap** — While this part requires secondary machining to be completed, its manufacture by impact extrusion saved greatly over the previous method of machining the entire part from bar stock.

● **Electric Motor Housing** — Impact extruding this part replaced several drawing and forming operations. While the impact extruded part has no particular performance advantage over parts made by other processes, manufacturing costs are far lower when the part is extruded. The matched ribs around the outer surface of this part illustrate the versatility of impact extrusions.

● **Hydraulic Cylinder** — This is another part extruded from high-strength alloy, 61S-T6. Previously machined from bar stock, it is far less expensive as an impact extrusion. The stepped wall at the open end of such a massive, heavy part is of particular interest — a bargain in metal saving.

● **Electric Motor Housing** — These parts were previously assembled from hollow extrusions. Switching to impact extrusions with an integral bottom proved much more economical and improved performance, too.

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Aluminum Extrusions

permit placement of metal where maximum strength is needed... save greatly in material and fabrication costs.

Almost any shape can be produced by Alcoa — hollow, semi-hollow, solid. While cross sections must remain constant throughout the length of the shape, extrusions permit thick sections where stresses are concentrated — thin sections in areas of minor loading. In both metal cost and shop time, extrusions often can save substantially over roll forming or building up an equivalent section.

To help you visualize the almost limitless possibilities of aluminum extrusions, and to suggest ways you can adapt your designs to them, Alcoa has prepared a special booklet that's yours for the asking. Write for "Alcoa Aluminum Extruded Shapes."

Booklet offers basic design help...

- a discussion of design and production advantages of aluminum extrusions.
- examples of aluminum extrusions that have increased strength and stiffness because of efficient metal distribution.
- examples of designs that have been simplified by the use of a single extruded shape to replace expensive built-up assemblies, castings or machined sections.
- illustrations of the way several extruded shapes can be combined to simplify assembly and reduce costs.
- suggestions on modifying designs to utilize standard shapes and shapes for which dies are available.

ALCOA

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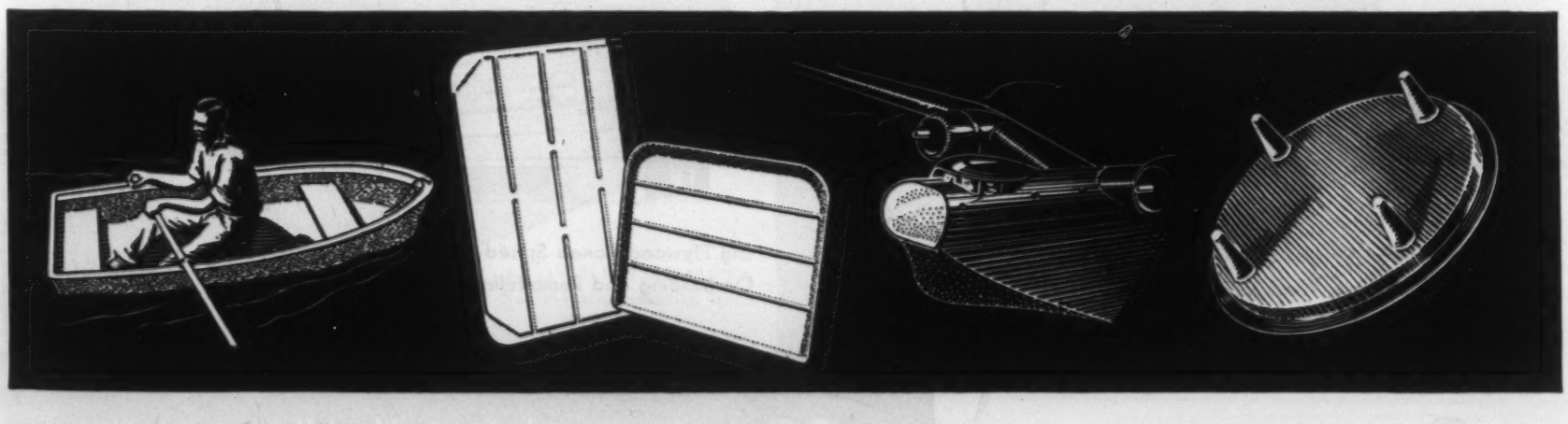
YOU TOO, MAY FIND NEW BUSINESS OPPORTUNITIES IN

REINFORCED Polyester PLASTICS

BAKELITE Polyester Resins constitute a fast-growing branch of the plastics industry. These resins are used in the production of reinforced plastics, chiefly with glass fiber mat or woven cloth. When properly formulated and applied they produce truly structural plastics with high strength-weight ratios that compare favorably with aluminum and steel. Present applications include boat hulls, refrigerator panels, radar housings, tote boxes, luggage.

In general, BAKELITE Polyester Resins provide excellent resistance to moisture, many chemicals, heat and cold. Certain types have excellent electrical characteristics including electrical "transparency" for radar housings. Another type can be cast into strong transparent solids. Another type is highly flexible and is used to impart added toughness to the other Polyester Resins. Inorganic fillers can be incorporated in certain of these resins to reduce costs and to minimize cracking and crazing.

Because BAKELITE Polyester Resins are "tailor-made" to meet widely different chemical, physical, and electrical requirements, Bakelite engineers will gladly assist you in choosing the right resins or combinations of resins for the intended end use. Write Dept. CL-17 for technical assistance and for latest data on the principal BAKELITE Polyester Resins now being marketed.



BAKELITE Polyester Resins are products of a continuing program of research and development. The principal grades now offered are:

High Viscosity Polyester Resin QRS-179 An excellent casting resin. May be prepared at room or elevated temperatures.

Med. Viscosity Polyester Resin QRS-147 A general purpose liquid resin with very good molding characteristics and excellent electrical properties. Adaptable to molding at room and elevated temperatures.

Low Viscosity Polyester Resin QRS-176 A low viscosity polyester resin which can be efficiently drawn into laminating layup under vacuum.

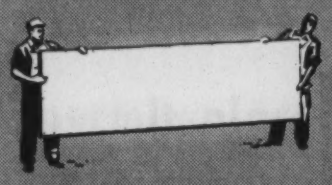
Heat Resistant Polyester Resin QRS-142 Generally similar in properties to QRS-147, it is designed to yield higher heat distortion points according to ASTM D 648-45T test method.

Flexible Polyester Resin QRS-136 For application where flexibility is desired. Also is completely compatible permanent plasticizer with other polyester resins to impart special properties.

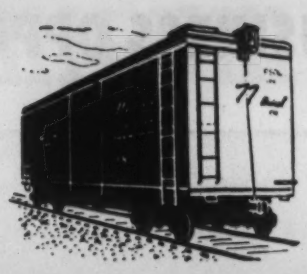
BAKELITE
TRADE-MARK
POLYESTER RESINS

TRADE MARK

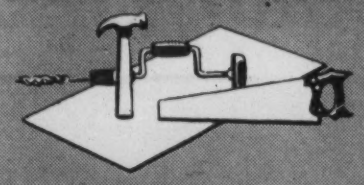
BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N.Y.



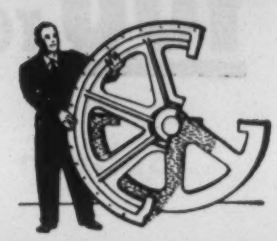
LARGE PANEL SIZE



Over 100,000 Railroad Cars
Have Plywood Siding and Lining

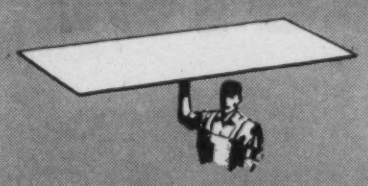


EASY TO WORK

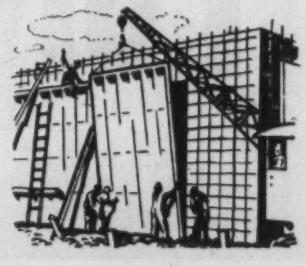


Plywood Simplifies Pattern Work;
Offers Design Adaptability

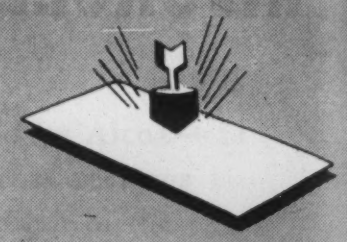
Low-Cost Plywood Bins Are
Easy To Build, Give Long Service



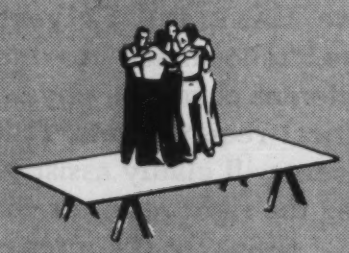
LIGHT WEIGHT



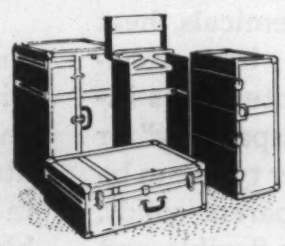
Re-Usable Plywood Concrete Forms
Speed Work, Lower Job Costs



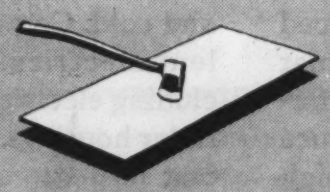
PUNCTURE-PROOF



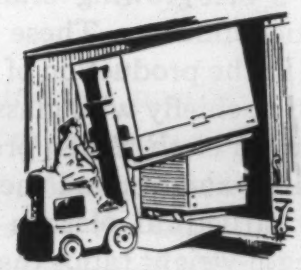
GREAT STRENGTH



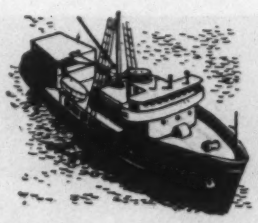
Plywood Boxes for Luggage
Lend Strength, Light Weight



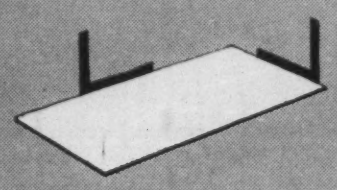
SPLITPROOF



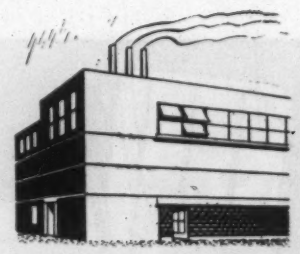
Long-lived Plywood Shipping Cases
Are Light, Strong, Re-Usable



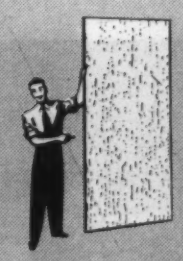
Durable Exterior Plywood Builds
Sea-Going Fishing, Work Craft



DIMENSIONALLY STABLE

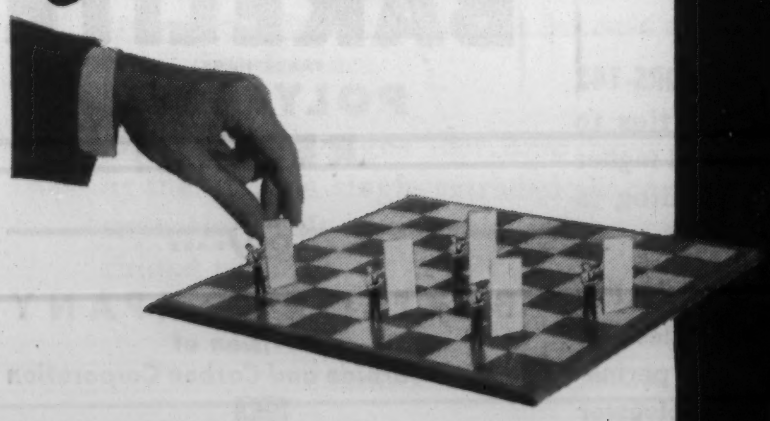


Big Plywood Panels Speed Work
On Building and Remodeling Jobs



NATURAL BEAUTY

Smart Move!

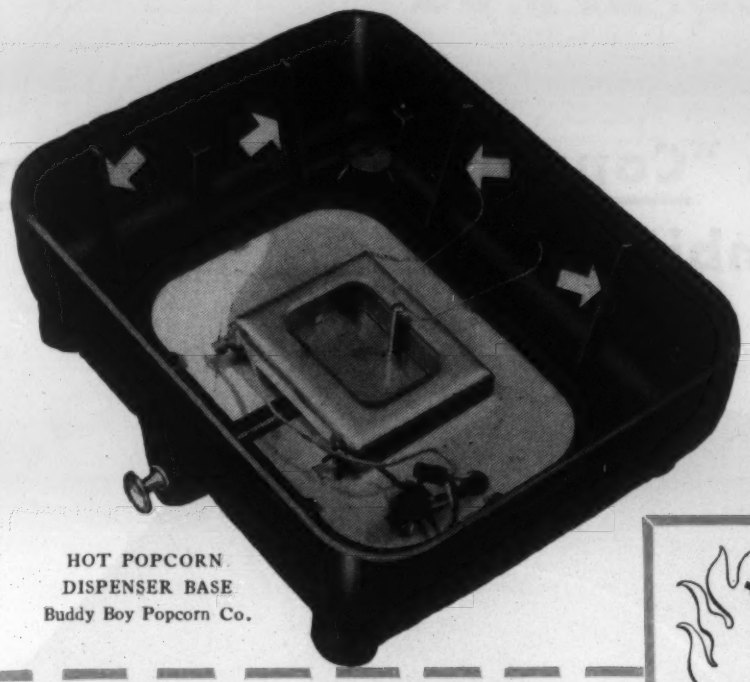


● Checkmate *your* production problem! Here's a versatile, economical, fast-to-work, hard-to-hurt material that can help you *right now!* Whether you need a material to speed work on a plant or a product, a tough, all 'round packaging and maintenance material or a dependable alternate for critical metals . . . make the *smart* move—to plywood. For information or technical assistance on special problems, write: (USA Only) Douglas Fir Plywood Association, Dept. 4610, Tacoma 2, Wn.

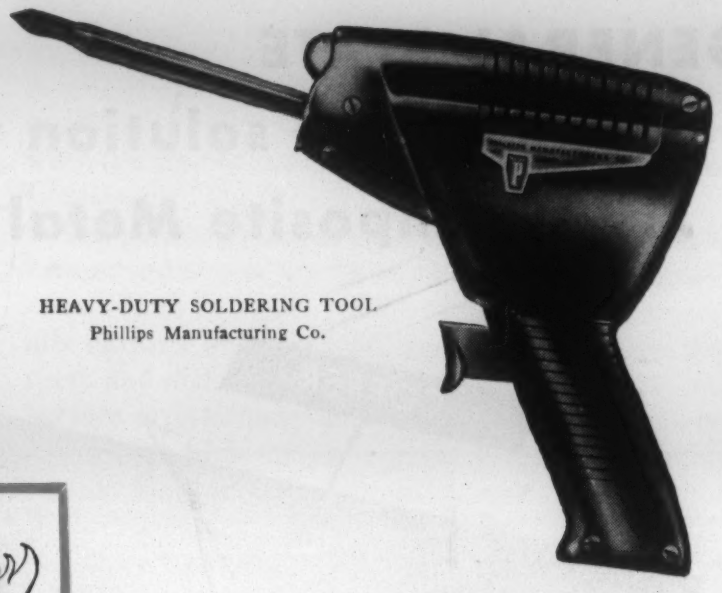
Douglas Fir
Plywood

AMERICA'S BUSIEST BUILDING AND INDUSTRIAL MATERIAL

HEAT needn't cool off ideas for better products



HOT POPCORN DISPENSER BASE
Buddy Boy Popcorn Co.



HEAVY-DUTY SOLDERING TOOL
Phillips Manufacturing Co.

ARVIN ELECTRIC IRON
Noblitt-Sparks Industries, Inc.

AUTOMATIC VAPORIZER
Practical Electric Products Co.

. . . just ask your molder about DUREZ phenolics

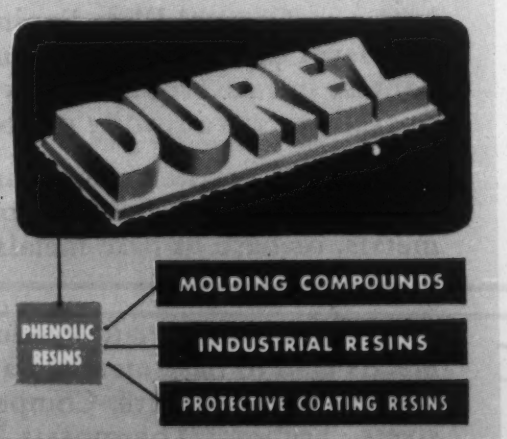
● Where heat conditions are involved, first thoughts on plastics in product planning sessions are naturally concentrated on the phenolics. These alone of all plastics are generally heat-stable up to 300° F., and in heat-resistant grades up to 400° F. and higher.

As specialists in developing phenolics to meet unusual as well as common requirements, Durez has carried heat resistance well beyond the limits of recent years. Recurrent temperatures in the area of 500° F. are being met by mineral-filled Durez compounds with no loss of dimensional stability, strength, luster and other desired properties.

The Durez in the vaporizer illustrated is impervious to mild solvents, hot or cold. The 15″ x 12″ x 5″ popcorn warmer base is warp-free. The iron handle never burns the ironer's hand. The soldering tool is safe and comfortable to use.

Whatever the product, your custom molder can help you see how heat resistance and other unusual properties of Durez can be used to advantage—in time and money.

Our field engineers are always ready with technical assistance.



Our monthly "Durez Plastics News" will keep you informed on industry's uses of Durez. Write, on office letterhead, to Durez Plastics & Chemicals, Inc., 1412 Walck Road, North Tonawanda, N. Y.

PHENOLIC PLASTICS THAT FIT THE JOB

PROBLEM:

How to get a good contact surface on Magnesium to provide proper joint conductivity?

GENERAL PLATE

Provided the solution with "Copper on Magnesium ... A composite Metal Combination"

Recently the General Plate was asked how to overcome the difficulty of attaching leads to magnesium and attain good joint conductivity.

General Plate Engineers provided the solution by bonding a thin layer of "copper on magnesium." This new type *clad* metal gave the contact surface required, as well as a surface on which soft soldering operations were readily performed.

No matter what your problem, it will pay you to consult with General Plate. Their vast experience in cladding precious to base metals, or base to base metals can overcome your problems . . . often reduce costs.

General Plate Products include . . . Precious metals clad to base metals, Base metals clad to base metals, Silver solders, Composite contacts, buttons and rivets, Truflex® Thermostat Metals, Alcuplate®, Platinum fabrication and refining, Age-hardenable, #720 Manganese Alloy. Write for information.

Have You a Composite Metal Problem? General Plate can solve it for you

GENERAL PLATE

Division of Metals & Controls Corporation

612 FOREST STREET, ATTLEBORO, MASS.

Customer Reports:

Asarco Continuous Cast Bronze Saves 20% in Metal Cost, Production Time

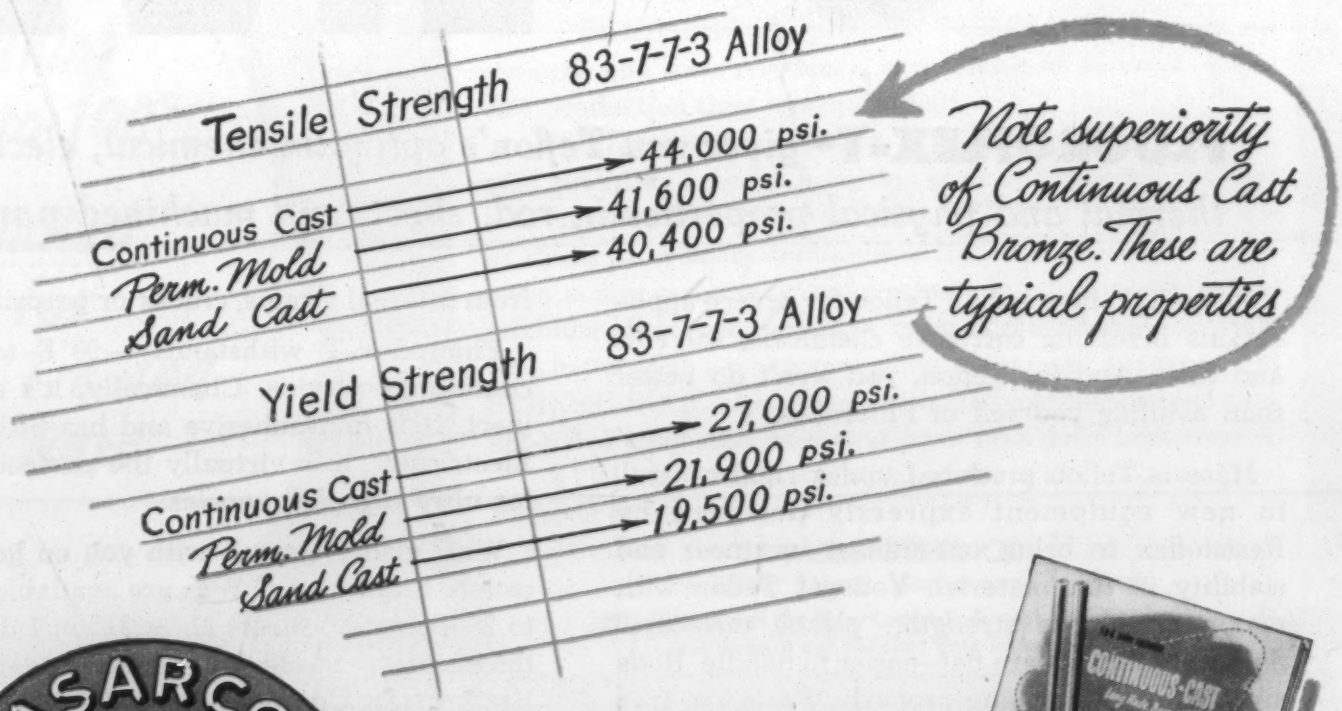
A manufacturer of packaging machinery tells of saving 20% in production time and 20% in material cost when he makes shaft bearings and nuts of Asarco Continuous Cast Bronze.

The patented Asarco casting process guarantees him bronze rod that is free from the hard and soft spots so often found in sand cast bronzes. Stock is exceptionally uniform and free from porosity. Since sand is not used, and dirt and dross are excluded, there can be no surface or internally trapped abrasive to dull tools or discourage high cutting speeds. Rejects are virtually unknown.

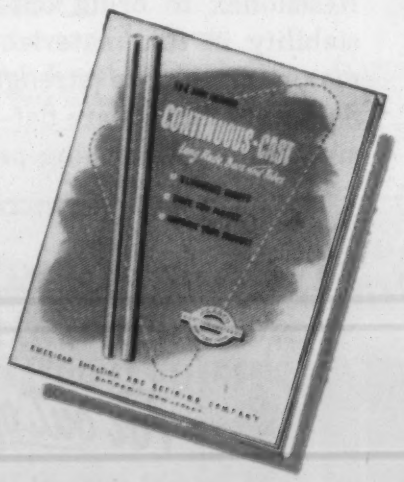
Dimensions are held to extremely close limits. For example, tube concentricities are within 1.5% of wall thickness. Dimensional uniformity is assured . . . machining on automatics is standard practice.

Continuous Cast Bronzes can be made to order in a wide variety of alloys . . . in standard lengths of 12′ . . . lengths 5′ to 12′ on request . . . lengths 12′ to 20′ on special arrangement.

216 sizes of standard Asarcon 773 bronze (SAE 660) are stocked in 105″ lengths for convenience at warehouses in all principal cities. Distributors will cut this stock long or short to suit your needs.



ASARCO CONTINUOUS-CAST RODS · TUBES · SHAPES ®



Send for this free catalog on Asarco Continuous Cast Bronzes. It contains physical properties, table of weights, photomicrographs, table of stock shapes and sizes and other data.

West Coast Sales Agent:
KINGWELL BROS. LTD., 444 Natoma Street, San Francisco, Calif.

American Smelting and Refining Company

OFFICES: Perth Amboy Plant, Barber, New Jersey
Whiting, Indiana

FLUOROFLEX-T* *gives you Teflon's optimum chemical, electrical, thermal and physical properties in rod, sheet, and machined parts*

You can't do better than Teflon for severe applications involving corrosive chemicals, solvents and heat. And for Teflon, you won't do better than availing yourself of Fluoroflex-T.

Here is Teflon produced under rigid control, in new equipment expressly designed by Resistoflex to bring out utmost inertness and stability in this material. You get Teflon with maximum tensile strength, "plastic memory," flexibility. Sheets are flat—easier to handle. Rods are uniform—machine properly. Parts are free from internal strains, cracks or porosity.

Fluoroflex-T withstands —90°F to +500°F continuous service. Chemically, it's essentially inert. It is non-adhesive and has little friction. Electrically, it is virtually the perfect insulator for ultra high frequencies.

We'll gladly consult with you on *your* application. Fluoroflex-T rods are available from ¼" to 2" diameter; sheets 21" x 21" in 1/16" to 1½" thicknesses; machined parts to specification. RESISTOFLEX CORPORATION, Belleville 9, N.J.

**Reg. trade name of Resistoflex Corp. for products manufactured from Teflon resin.*

For out of the ordinary engineering with synthetics

RESISTOFLEX
CORPORATION
Belleville 9, New Jersey

This thickness control screw, made from STRESSPROOF steel bar, is a vital part of the asphalt road layer shown laying an air strip at a Pacific base.

COSTS DOWN 25%
PRODUCTION UP 100%

WHEN STRESSPROOF® REPLACED HEAT-TREATED .40 CARBON ALLOY STEEL BARS

- *Speeded Machining 50% to 100%*
- *Eliminated need for Heat Treated Alloy Bars*

In this asphalt road layer, instead of using a heat-treated, hot-rolled .40 carbon alloy bar, STRESSPROOF was specified. STRESSPROOF provided *in-the-bar* the necessary strength and wear resistance, and machined so much easier that production time was cut in half.

STRESSPROOF's unique combination of four important qualities *in-the-bar* is cutting costs and speeding production on many similar defense jobs. STRESSPROOF is twice as strong as ordinary cold-finished bars. Its resistance to wear often makes carburizing unnecessary. It is stress-relieved to minimize distortion, and has *in-the-bar* machinability fully 50% better than heat-treated alloys of the same hardness. Yet STRESSPROOF is less expensive than all cold-finished and most hot-rolled alloy steel bars that have been fully heat treated.

STRESSPROOF is also available with a Ground and Polished finish.

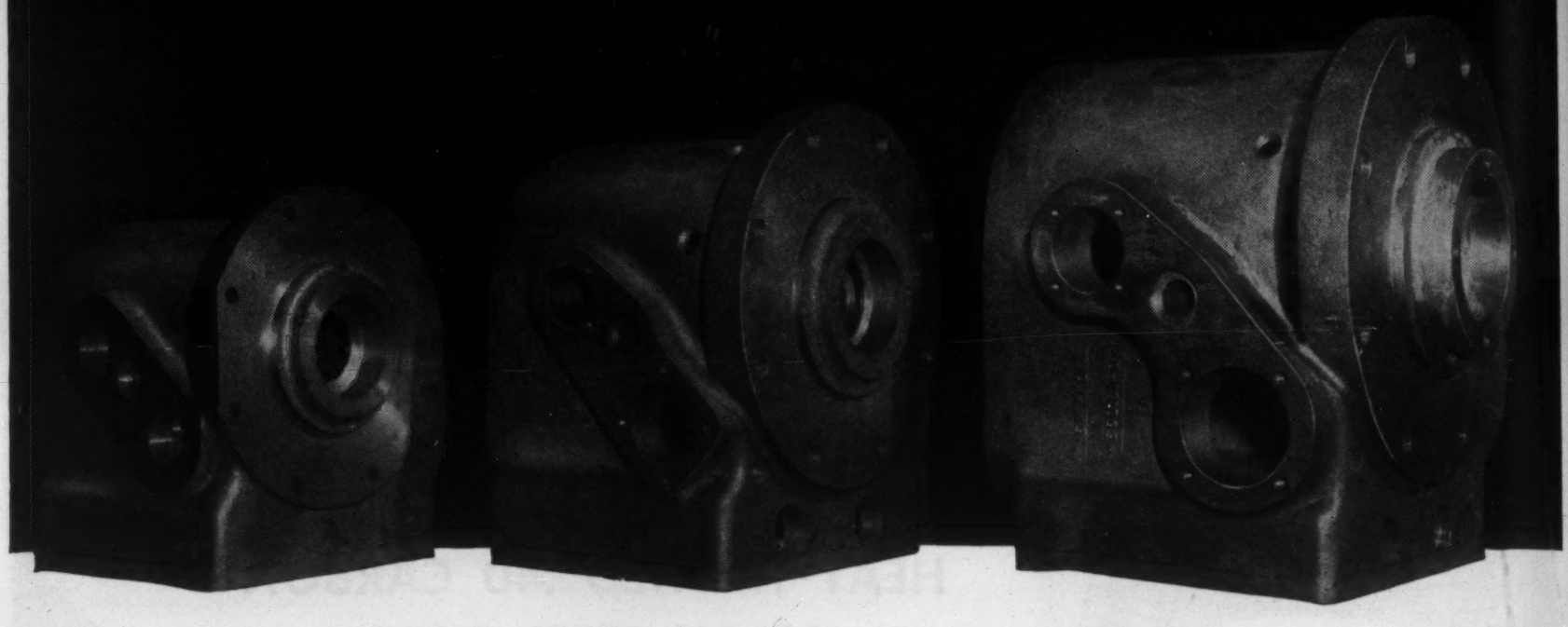
LASALLE STEEL CO.
1418 **150th Street, Hammond, Indiana**
Manufacturers of the Most Complete Line of Cold-Finished and Ground and Polished Bars in America

La Salle
STRESSPROOF®
SEVERELY COLD-WORKED, FURNACE-TREATED CARBON STEEL BARS

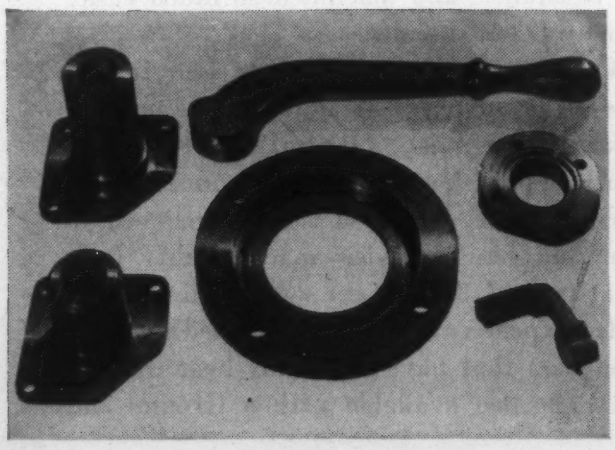
STRESSPROOF IS PLAYING A VITAL ROLE IN NATIONAL DEFENSE!

A very large proportion of STRESSPROOF production, today, is going into defense jobs. However, from time to time sample bars may be available for testing purposes.

"fully satisfies loading conditions..."



So again the choice is: GRAY IRON



Specify gray iron for smaller operating parts, too, like these components of the torque control pictured above.

MAKE IT BETTER WITH GRAY IRON

Second largest industry in the metal-working field

BECAUSE GRAY IRON DOES THE JOB AT LOWER COST, the designer specified gray iron castings for this torque control housing. He knows you can't beat gray iron for ready machinability at a specified pressure strength level.

GRAY IRON GIVES YOU ALL THESE ADDED PRODUCTION ADVANTAGES: Castability, rigidity, low notch sensitivity, wear-, heat- and corrosion resistance, durability, vibration absorption, wide strength range.

SO SPECIFY GRAY IRON when you need a part that must meet many structural and functional requirements—with economy. We know gray iron will satisfactorily serve your needs.

SCRAP IS NEEDED FOR DEFENSE—KEEP IT MOVING!

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

Tail Light—Stop Light Lens

Front and Rear Crest

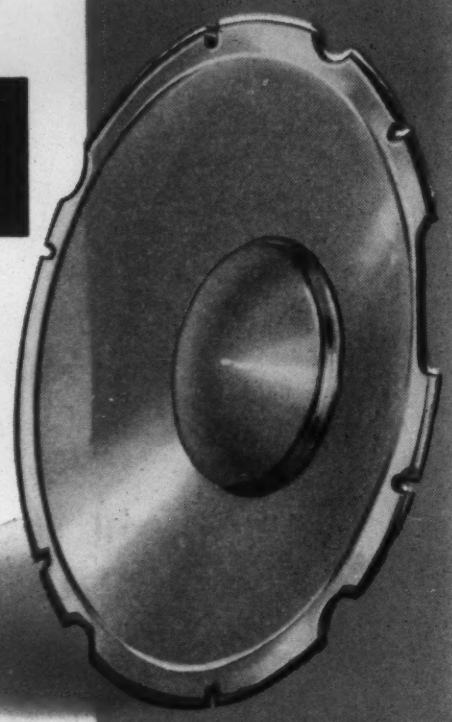
Again... FORD Uses

PLEXIGLAS

for Molded Automotive Parts

"Built for the years ahead," '51 Fords are extra husky and handsome. Their visible plastic parts must have *lasting* beauty and strength—and PLEXIGLAS V acrylic plastic molding powder meets the requirements. Inside and outside cars, and inside and outside the automotive industry, PLEXIGLAS V molded parts have beauty, dimensional stability, and outstanding resistance to heat, age, and weather. Write for our booklet showing typical parts molded from PLEXIGLAS acrylic plastic molding powders.

Fordomatic Drive Indicator



Instrument Panel Lens

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

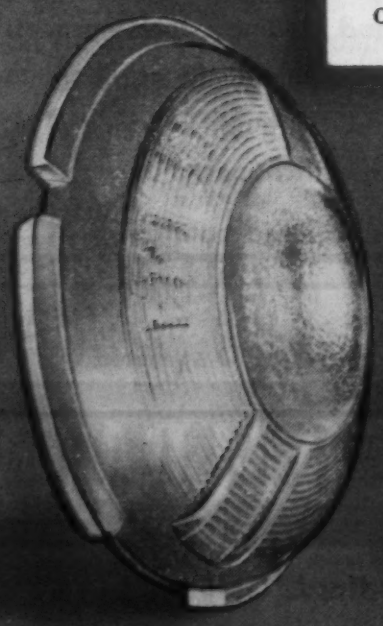
WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

PLEXIGLAS *is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries*

Canadian Distributor: *Crystal Glass & Plastics, Ltd.*
130 Queen's Quay at Jarvis Street, Toronto, Ontario, Canada

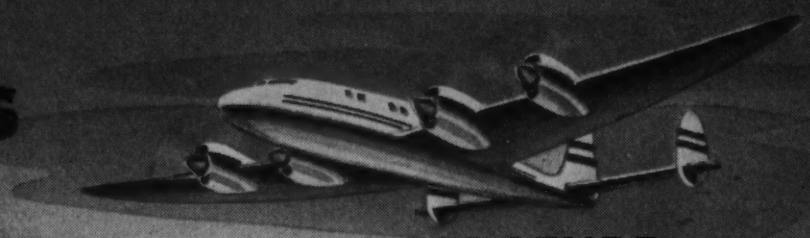
Instrument Panel Escutcheon



Parking Light Lens

Steering Wheel Ornament

Rubber Parts to Resist . . .



TEMPERATURE

OILS and GAS

WEATHERING

CHEMICALS

ABRASION

STALWART-developed rubber compounds are available in mass produced parts to meet your applicational requirements. These parts retain their physical, chemical and dielectric properties regardless of the effects of extreme temperatures, oil and gasoline, chemical action, abrasion and weather.

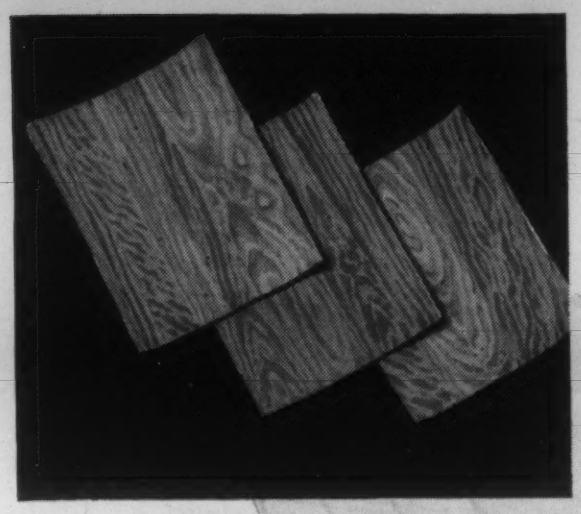
STALWART rubber compounds are supplied in precision molded, extruded, die-cut and lathe-cut shapes for application in aircraft, automobiles, trucks, marine equipment, railroad rolling stock, processing equipment, electrical assemblies, and other equipment. In addition, these parts can have varying degrees of hardness, tensile strength, and elongation to meet individual, S.A.E. or A.S.T.M. specifications.

Write today for the new 16-page illustrated multicolored catalog Number 51SR-1 for additional details.

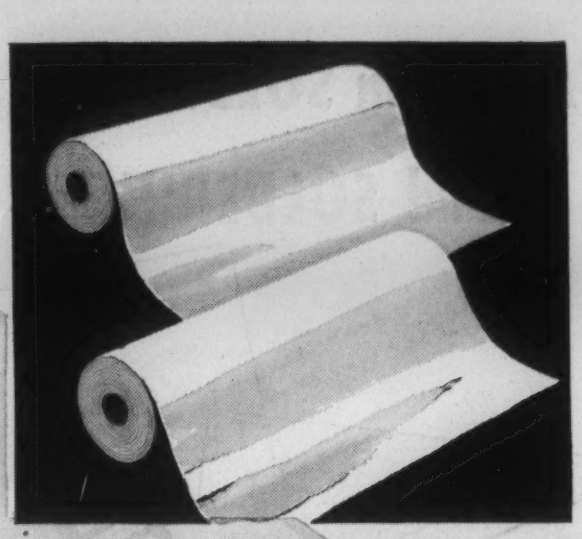
192-SR

STALWART RUBBER COMPANY

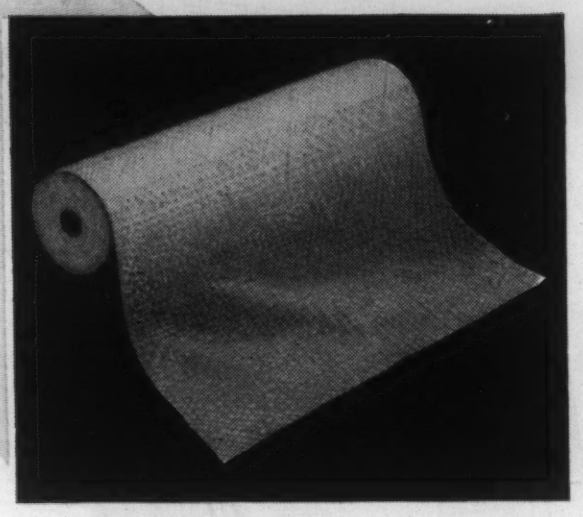
12165 Northfield Road • Bedford, Ohio



IMPREGNATES WOOD



PAPER



CANVAS

stretch your LAMINATING dollars with versatile

No. 5015 PLYOPHEN

Here is a liquid resin that not only pays off on fast, deep penetration and versatility of application, but on dollar stretching economy as well! Ideal for the impregnation of wood, canvas, asbestos and paper, No. 5015 gives you more for your money because it goes farther—dilution ratio may be increased up to ten parts water to one part resin! No. 5015 is also being used by some manufacturers in the production of Compreg. So why not find out how this widely used and useful resin can help you? For further information together with a working sample, write direct to the RCI Sales Department in Detroit.

REICHHOLD CHEMICALS, INC.

Executive Offices, International Building, New York 20, N.Y.
Main Plant, Detroit 20, Michigan

Other Plants: Brooklyn, New York
Elizabeth, New Jersey • South San Francisco and Azusa, California • Tuscaloosa, Alabama • Seattle, Washington • Chicago, Illinois • Charlotte, N. C.
Liverpool, England • Paris, France • Sydney, Australia • Sassenheim and Apeldoorn, Holland • Naples, Italy • Buenos Aires, Argentina • Hamburg, Germany
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SYNTHETIC RESINS • CHEMICAL COLORS • PHENOLIC PLASTICS • PHENOL • GLYCERINE
PHTHALIC ANHYDRIDE • MALEIC ANHYDRIDE • SODIUM SULFATE • SODIUM SULFITE

FREE CATALOG on SOLDERS and SOLDERING!

LEARN HOW CORRECT TECHNIQUES CAN CONSERVE METAL AND MONEY

Government regulations have restricted the free use of tin in solder. We have been told to conserve . . . substitute . . . in effect, to solder best with what is most readily available.

Although the art of soldering appears simple, it requires considerable skill and ingenuity to produce a joint of optimum properties. Merely placing the parts together, heating and applying solder is not sufficient. A thorough knowledge of the fundamentals is needed in order to use solder efficiently and to best utilize the tin and lead allotted for this purpose.

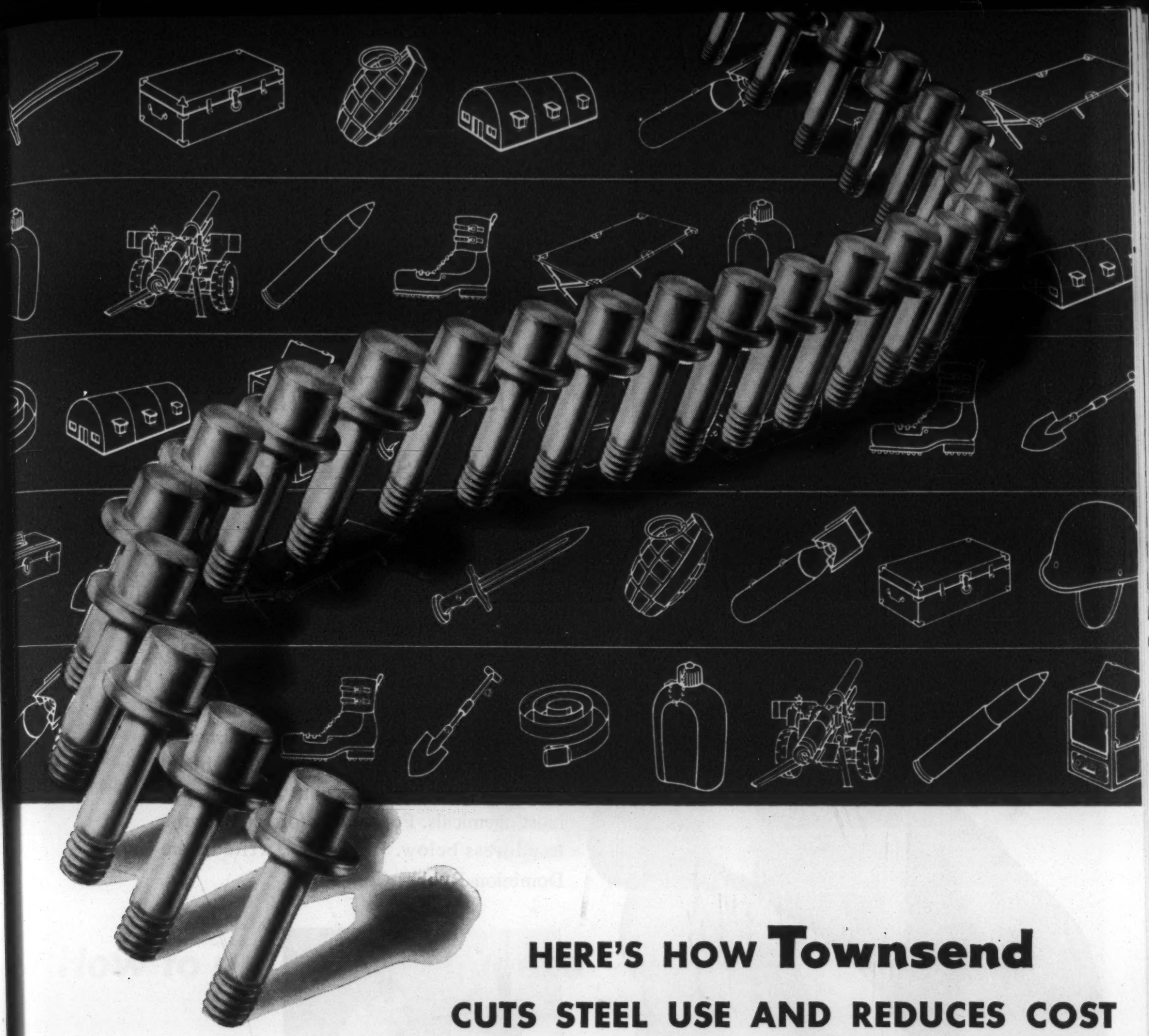
To help you with solders and soldering, Federated Metals Division, American Smelting and Refining Company, has published a 36-page catalog presenting the properties of various solders and some of the fundamental principles governing uses and applications. Included are data on how to select a solder for a specific application . . . mechanical properties measured in terms of tensile strength, shear strength and impact strength . . . methods of cleaning preparatory to soldering . . . amounts of solder needed to obtain maximum joint strengths . . . the role of fluxes in assuring proper bonding . . . and full specification tables.

For your free copy of this timely and informative catalog . . . for help with soldering or any non-ferrous metals problem . . . write Federated NOW.

Federated Metals Division

Federated first in the non ferrous field FMD

AMERICAN SMELTING AND REFINING COMPANY • 120 BROADWAY, NEW YORK 5, N.Y.



HERE'S HOW Townsend CUTS STEEL USE AND REDUCES COST ON THIS DEFENSE ITEM

The part shown above for use in a smokeless powder box was originally made from bar stock which wasted hundreds of tons of critical steel. Townsend engineers suggested that by a slight change in design the part could be cold headed from wire thus saving considerable steel and reducing the cost greatly. We are not permitted to reveal the number of parts made, but the aggregate savings both in money and steel was substantial.

This is typical of how Townsend saves time, money and material for customers by drawing upon its long experience in cold-heading to produce quality parts and fasteners with economy. When you work with Townsend in designing and producing military or civilian items you enjoy the benefit of this experience.

Townsend products for defense range from hob nails for field boots to rivets for half tracks — from special nails for gliders to artillery firing pins — even balls for canisters.

To learn more about the savings in time, money and critical materials that are possible when you have Townsend design and produce your small parts and fasteners, write or phone today.

Townsend

COMPANY • ESTABLISHED 1816

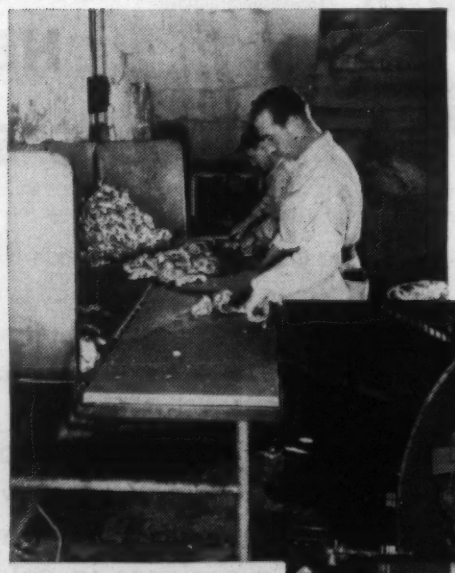
Plants—New Brighton, Pa. · Chicago 38, Ill.

Cherry Rivet Company Division, Los Angeles, California

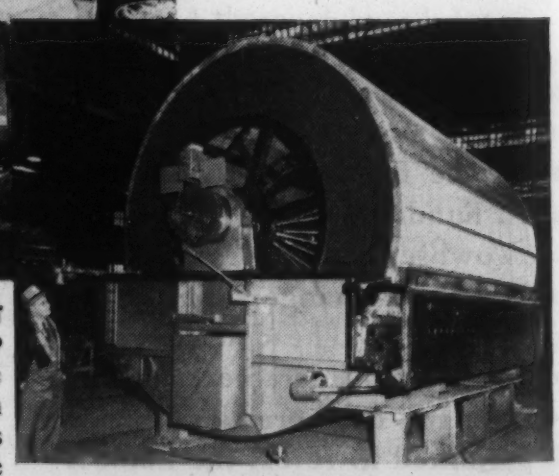
Sales Offices in Principal Cities

What's U. S. Rubber doing with Plastic Pipe?

Giving it extremely high impact strength, for one thing. A single .44 cal. revolver bullet, fired at a distance of 20 yards, merely dented this piece of pipe, which is made of U.S. Rubber's new plastic, Uscolite. This amazingly strong, lightweight, versatile piping is easy to handle, won't break if dropped. Furnished in standard lengths, it can be cut to length and threaded on the job. Uscolite is resistant to most chemicals. For more information, write to address below. In Canada, write to the Dominion Rubber Company.



U.S. ROYAL MEAT CUTTING TABLE TOP made of Uscolite stands up longer than wood. U.S. Royal tops retain their shape, are easier to clean.



THIS CONKEY FILTER, part of the sanitation system of a midwestern city, is equipped with Uscolite piping. Uscolite handles corrosive acids, alkalies, salts.

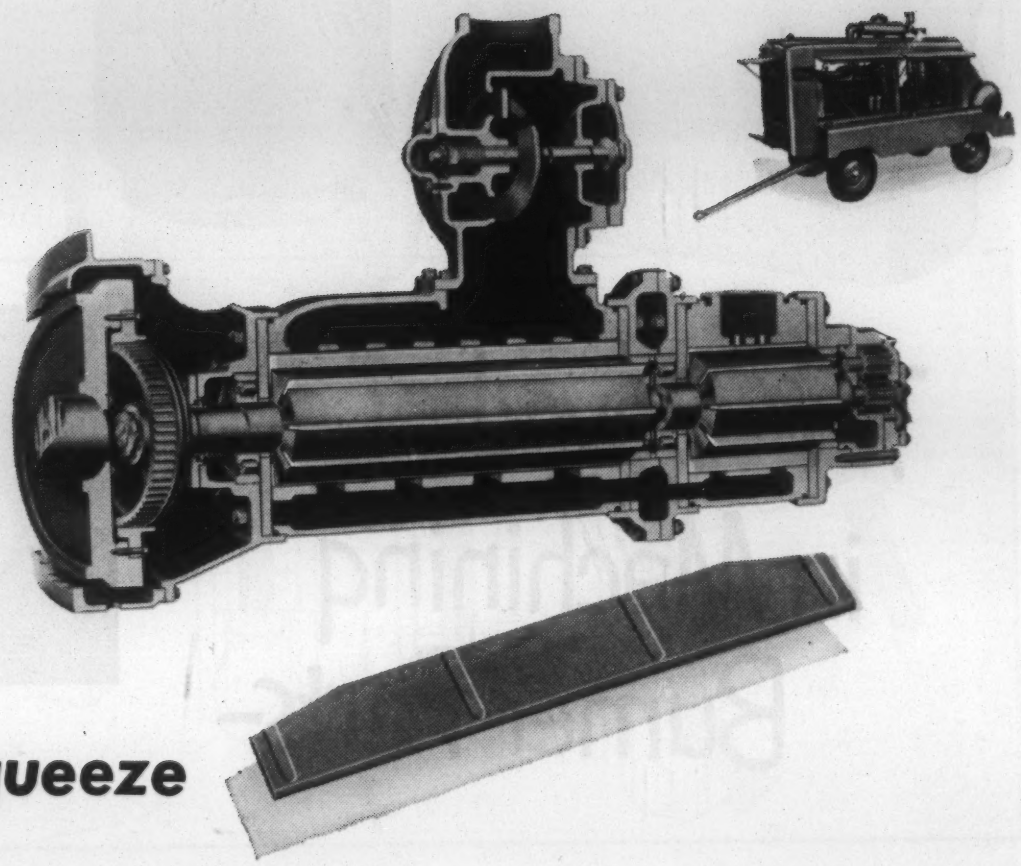
PRODUCT OF

U.S.RUBBER

SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.



How to put on the squeeze

In the illustration above you see vanes used in the new Ingersoll-Rand Gyro-Flow portable air compressors. These vanes do an unusual job. They are made from an unusual material—Synthane laminated plastic.

The vanes are inserted in slots in a rotor which is mounted off-center in a cylinder. As the rotor spins, centrifugal action forces the Synthane vanes against the inside of the cylinder to form chambers between the vanes. Because of the eccentric mounting, these chambers constantly change in dimension. As they enlarge, air is drawn through intake ports in the cylinder walls. As they contract, the air is forced under pressure through discharge ports.

The result is a steady flow of compressed air without pulsation or vibration. Because of the complete simplicity of the machine, the compressor is lighter, more efficient, more economical to operate than conventional compressors.

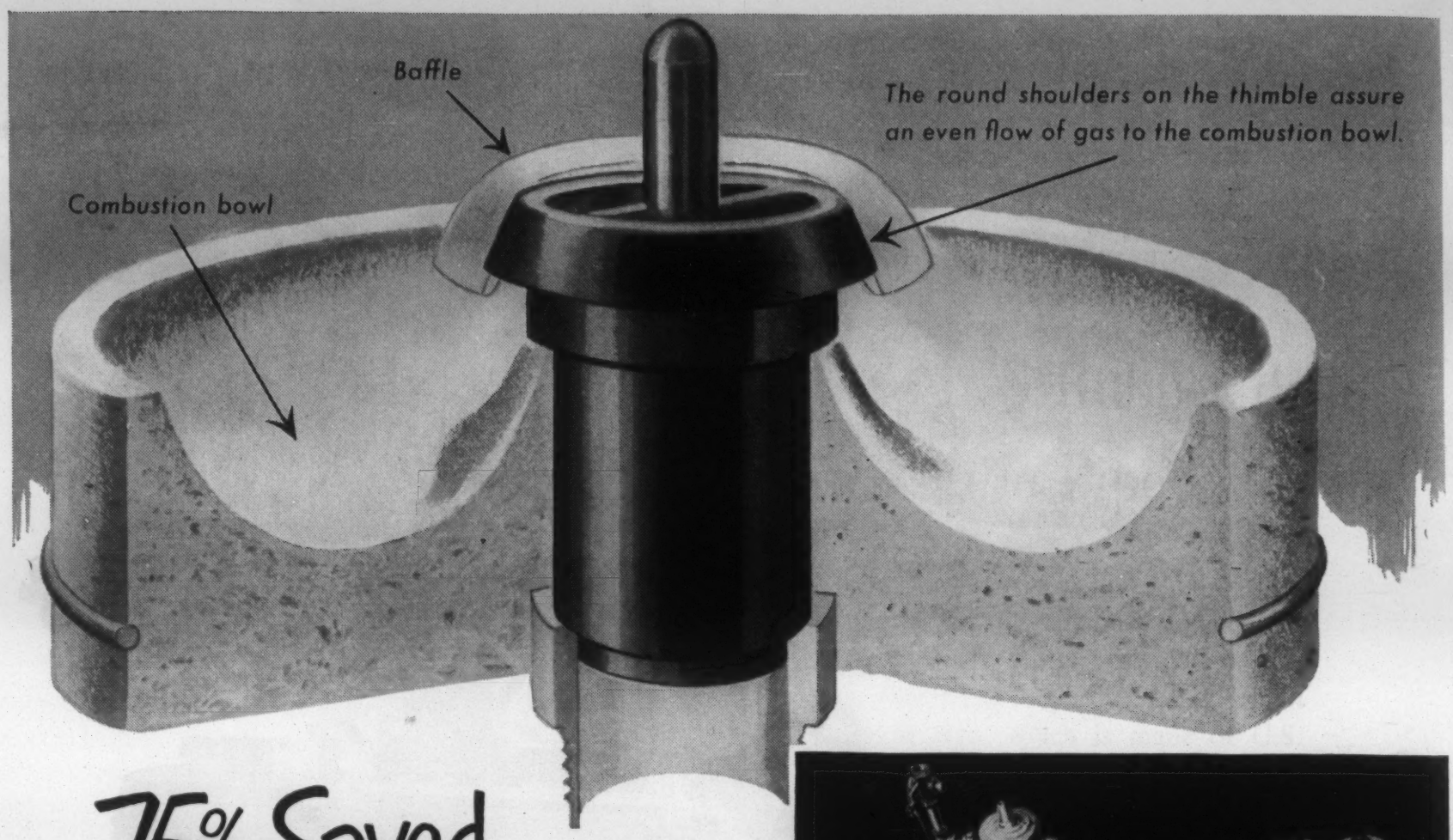
It is apparent that the vanes are important components. They must be strong, light in weight, unaffected by the oils used to lubricate and form an air-tight seal between the vanes and the cylinder walls. They must be hard and dense to stand up under continuous operation yet not so hard as to score the walls of the cylinder.

Synthane has all of these properties and many more. In fact, it has so many useful mechanical, electrical and chemical characteristics that it cannot be adequately described in less than a complete catalog. If you have need for such material, a catalog containing a complete description of Synthane may be obtained by writing Synthane Corporation, 23 River Rd., Oaks, Pennsylvania.

PLASTICS WHERE PLASTICS BELONG

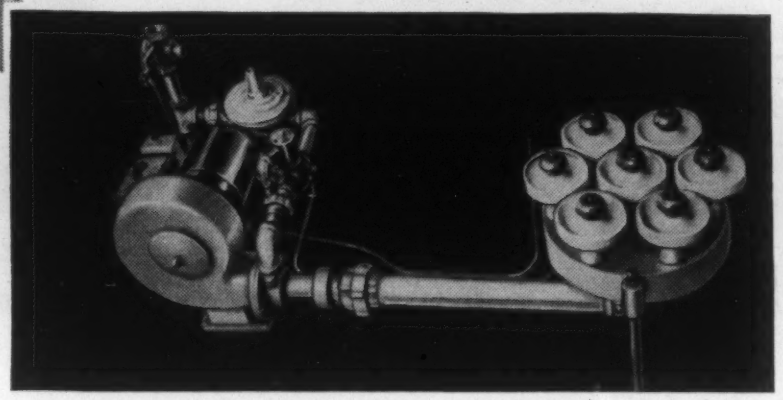
SYNTHANE

Manufacturers of laminated plastics



75% Saved in Machining Burner Parts—

A manufacturer of infra-red gas burners has realized a saving of 75 per cent in machining costs by switching from sand castings to HAYNES precision castings for an integral part of the burner. When this part—called the thimble—was produced by sand casting, every surface had to be machined to assure uniform smoothness and accuracy. Now that investment-cast parts are being used, these costly operations are no longer necessary. Only two simple threading operations are needed before the thimbles are installed in the burners.



This gas burner unit—equipped with investment-cast thimbles—is used to furnish radiant heat in private homes. Similar units are used in industry for paint drying, degreasing, annealing, baking, and roasting.

An additional saving results from the fact that the HAYNES investment castings are so sound that none of them has ever had to be rejected. When sand castings were used, at least 10 per cent of them were rejected for flaws opened up in machining.

For ideas on how you can save through the use of these sound, accurate parts, write for the booklet, "Investment Castings."

HAYNES TRADE-MARK *alloys*

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles—New York—San Francisco—Tulsa

"Haynes" is a trade-mark of Union Carbide and Carbon Corporation.

Reynolds

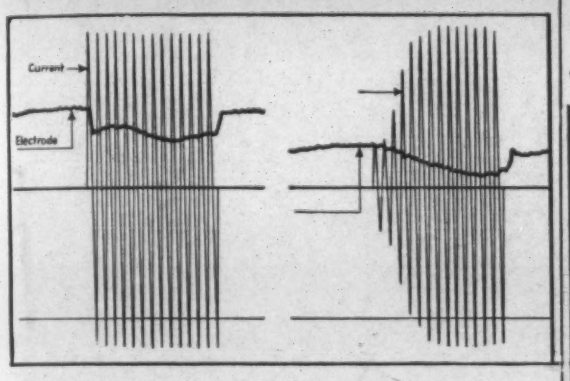
ALUMINUM REPORTER

A SERVICE TO INDUSTRY ON ALUMINUM USES AND DEVELOPMENTS

NEW MECHANICAL FASTENING METHODS BOOKLET

New Control System Extends Electrode Life 20-30 Times When Spot Welding Aluminum

A new system called "slope control", that extends electrode life 20-30 times when spot welding aluminum with ordinary alternating current welders, has been developed by General Electric and is recommended by Reynolds Metals Company technical staff.



Tip-pressure tracing without (left) and with (right) "slope control"

The new control system restricts the flow of welding current during the first few cycles, allowing the welding current to build up gradually to maximum. This reduces softening of metal under the electrode tip, helps maintain tip pressures, and holds down tip temperatures, thus reducing "sticking" almost to the vanishing point.

In certain oscillograph curves traced during the testing of this system, total amount of heat produced at electrode tips was seen to be something less than one-sixth the usual amount, cutting tip temperature rise tremendously.

For further information on this new system, write for your free copy of the Reynolds Technical Advisor No. 15. Any engineer, designer or executive who requests it on business letterhead will be placed on the mailing list to receive copies of the "Advisor" as issued.

For assistance on any *special* production problem, call on the trained staff of Reynolds Aluminum Specialists ready to help you overcome difficulties and obtain maximum benefits from your aluminum. Call the Reynolds distributor listed under "Aluminum" in your classified telephone directory, or write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky

Reynolds Building Largest Gas-Burning Electric Power Plant

To supply the tremendous electric power requirements in its new 80 million dollar aluminum reduction plant at Corpus Christi, Texas, the Reynolds Metals Company is installing 78 internal combustion engines totalling 256,300 horsepower and driving direct-current generators with a total rated output of 176,000 kilowatts. Using natural gas for fuel, it will be the largest gas-burning engine plant so far built anywhere in the world.

Latest Data on Various Types of Mechanical Joints and Fasteners Now Available Upon Request

The Technical Editorial Service of the Reynolds Metals Company has produced a new technical book, "Mechanical Fastening Methods for Aluminum."

As stated in the foreword, "In addition to welding, brazing and soldering, a wide variety of mechanical fastening methods are used to join assemblies involving aluminum parts. This book represents an endeavor to supply the designer and manufacturer with data on the various types of mechanical joints and mechanical fasteners for use with aluminum."

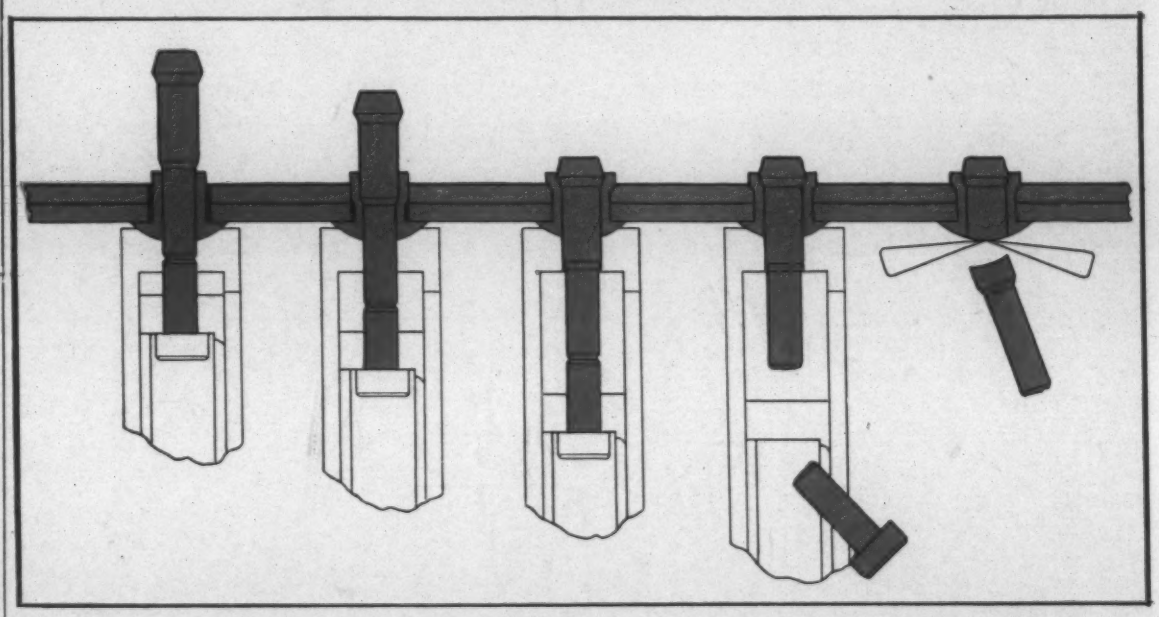


Diagram showing cross-section of method for fastening with self-plugging blind rivets. This is typical of the many explanatory illustrations found in Reynolds newest technical book, "Mechanical Fastening Methods for Aluminum."

Containing all you need to know about fastening aluminum components, this 136-page illustrated booklet is a *must* for your desk reference library. Its handy pocket size makes it ideal for easy carrying and ready accessibility in the shop.

There are tables of related data for the various types of standard rivets, including dimensions and number of pieces per pound, lengths of rivets for cone-point and button-type driven heads, recommended hole sizes with shear and bearing areas for both hot and cold-driven rivets, and maximum loads for single rivet in shear.

You will find in this book answers for your questions on standard and special rivets, standard and special screw fasteners, nails and pins, metal stitching, mechanically formed joints, resin bonding and others.

Illustrated above is an example of one of the complete diagrams explaining the method of riveting, using self-plugging blind rivets.

Application of the latest 1951 fastening methods like these means increased production capacity and lower costs for every type of aluminum assembly.

The Reynolds Metals Company states in the book that they will be glad to grant permission to any technical writers to use transcripts from the book. Also, technical writers and editors may obtain glossy 8 x 10-inch photoprints of any of the book's illustrations.

For manufacturers or designers having a special development problem not covered by this book, Reynolds offers the services of its trained staff of aluminum specialists. Let them show you how to overcome difficulties and set up for fast, economical production. For prompt service, call the Reynolds field office listed under "Aluminum" in your classified telephone directory.

(A reprint of the book's riveting section, the most important mechanical joining method, is available in quantities for distribution to students in schools, colleges and technical groups without charge.)

For your *free* copy of the valuable handbook described above, plus a complete index of Reynolds technical literature, write on business letterhead (otherwise price is $1.00) to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

Printed in U. S. A.

Aluminum Pipe Makes Portable Sprinkler Irrigation Reality

Use of portable sprinkler irrigation systems on American farms has grown spectacularly since 1945. One of the largest factors causing this increase has been the tremendous advantage of aluminum irrigation pipe.

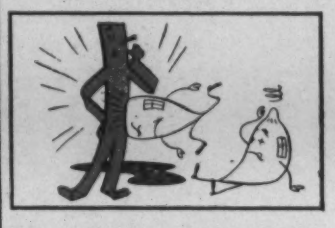
Extreme portability due to light weight, great strength offering high pressure resistance, plus rust and corrosion resistance . . . all these contributed to the demand for aluminum irrigation pipe and made *portable* sprinkler irrigation a reality.

During the present emergency, aluminum pipe of this type is being used as the basic component of the "Superbazooka", the 3.5 inch rocket-launcher. If you can find a use for extruded aluminum tubing in the design of your future products, call the Reynolds Aluminum Specialist . . . let him work with you to assure the maximum benefits of aluminum. His development and research skill is backed by the experienced staff of the Reynolds Technical Service. For further information call the Reynolds distributor listed under "Aluminum" in your classified telephone directory. Or, write Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

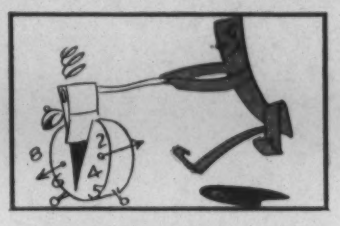
New Idea for Artists' Medium

Swiss experiments indicate that ⅛-inch aluminum, coated with a porous oxide skin, provides a practical and permanent working foundation for oil painting. It doesn't tear, split or wrinkle like canvas and takes less storage space. The smooth surface paints easier, gives more brilliant colors.

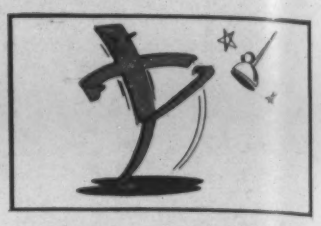
Shippers of Defense Material Find Nothing Protects Like Aluminum Foil



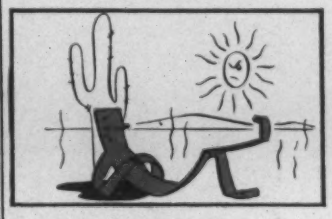
Keeps Moisture Out—Reynolds Plain Aluminum Foil is a positive barrier against transmission of moisture vapor. In gauges .0015" and heavier, it has a zero moisture-vapor-transmission rate.



Cuts Packaging Time—Reynolds Plain Aluminum Foil offers maximum conformity to the object to be packaged. Shapes easily by hand. No valuable time lost tying, binding or taping.

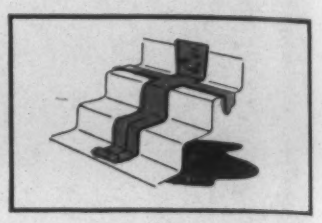


Naturally Greaseproof—Reynolds Plain Aluminum Foil prevents greases on parts from drying out or hardening, thereby losing their value. Aluminum is naturally greaseproof on both sides.



Maintains Top Efficiency Indefinitely—Reynolds Plain Aluminum Foil does not depend on treatments for waterproof qualities, therefore it is not affected by long exposure to dry air or heat.

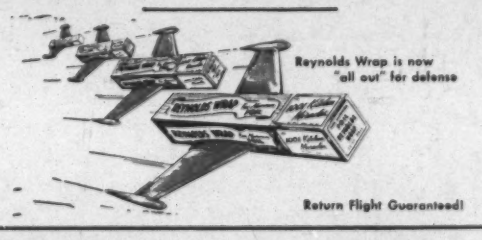
Absolutely Non-Absorptive—Reynolds Aluminum Foil does not absorb dipping compounds as other barrier materials do. This means a direct cash saving on the dipping material used.



No "Spring Back"—Reynolds Plain Aluminum Foil is "dead soft" and holds molded contours. Excellent for parts impractical to package by old-fashioned methods and materials.

Reynolds Pure Aluminum Foil is particularly suited as an intimate wrap for parts which have large air voids and cannot be dipped without undue bubbling. The ease with which it conforms to and holds shape leaves less "dead air space" in package.

For your copy of the FREE booklet "How, Why and When You Should Consider Protective Packaging with Aluminum Foil" write Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.



Aluminum Medical Chest Another Example of Reynolds Parts Fabrication Service

Complete Facilities Help Manufacturers with Military Orders

Another example of the complete and valuable service to industry performed by the Reynolds Parts Fabrication Service, these aluminum medical chests are now being produced for the Armed Forces Medical Units. The wide range of facilities available to manufacturers through the use of this service is demonstrated by the blanking, drawing, spot-welding, seam-welding, finishing and other allied operations necessary to produce this type of chest.

Formed of Reynolds .091" Aluminum, these chests have reinforced corners and welded gasket retaining channels for strength and rigidity. Flush mounted hardware allows containers to be stacked on any side. Stacked flat, the nesting feature of the design prevents sliding even when stack is tilted. Gum rubber gaskets assure water-proofing.

Shipping containers like these are only one of the many applications of the skill and production facilities of the Reynolds Parts Fabrication Service. This service provides all manufacturers with extra assembly lines when needed. Through the use of this program, the manufacturer is assured of a steady flow of inspected parts whenever needed and in whatever quantities desired. Quotations on aluminum parts can be furnished to the manufacturers' designs and specifications.

Probably one of the most important features of the Parts Fabrication Service is the tremendous savings in vitally needed scrap . . . averaging 30% and often as high as 75%! This results in savings on shipping, storing and handling charges plus making important scrap readily available for remelting at the mill. On "DO" orders where the allocation is in pounds of metal, the manufacturer gets full value from his allocation, receiving the exact number of parts available from the pounds of metal allocated.

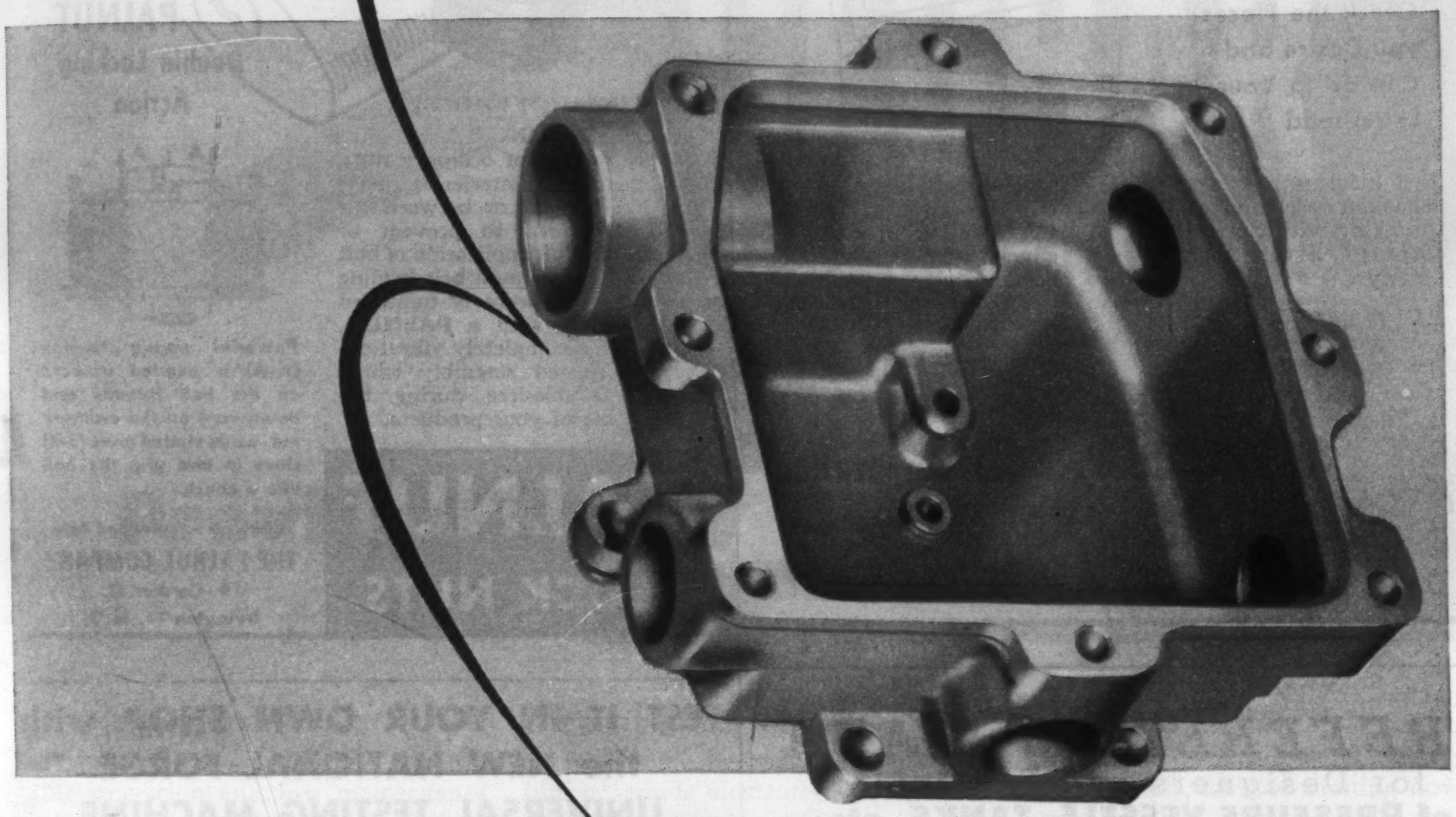
For further information on the Parts Fabricating Service and how it can help your production, merely call the Reynolds office listed under "Aluminum" in your classified telephone directory. Or, write to Reynolds Metals Company, 2065 South Ninth Street, Louisville 1, Kentucky.

New Book Tells Complete Reynolds Aluminum Story

A new booklet has been prepared for distribution to all those interested in modern metal developments. This 45-page booklet, "Reynolds Aluminum and the company that makes it", is the first complete compilation of the facts about the company that did more than any other to bring America's aluminum production up to the point it has reached today. The booklet presents the principal operations of Reynolds Metals Company under "normal conditions" and during the present rearmament program.

Profusely illustrated and handsomely bound, the booklet is available upon request to those writing on business letterhead. Address the Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

Flexible DESIGN POTENTIALS



with **MADISON-KIPP** *Zinc and Aluminum*

DIE CASTINGS

Space limitations, usage and other reasons may dictate a complicated part like the precision airplane switch housing illustrated. There are cored holes and bosses on six sides plus an interlocking core. The Madison-Kipp die casting process is ideal for producing these "special" shapes and offers the designer great flexibility within a reasonable cost budget. Please send all inquiries to our home office in Madison, Wisconsin.

MADISON-KIPP CORPORATION

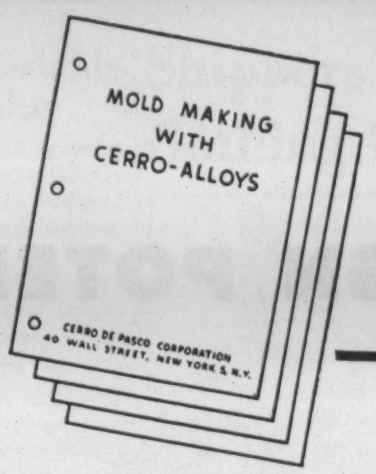
218 WAUBESA STREET, MADISON 10, WIS., U.S.A.

ANCIENS ATELIERS GASQUY, 31 Rue du Marais, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

WM. COULTHARD & CO. Ltd., Carlisle, England, sole agents for England, most European countries, India, Australia, and New Zealand.

- *Skilled in* DIE CASTING *Mechanics*
- *Experienced in* LUBRICATION *Engineering*
- *Originators of Really High Speed* AIR TOOLS

FREE
Engineering Data on CERRO ALLOYS Available Now ! !



Check the Pieces you Desire and Clip ad to Your Letterhead

☐ Informative 8-page booklet describing mold-making with Cerro low-temperature melting alloys.

☐ Single sheet on the correct casting procedure of Cerro Alloys.

☐ Helpful 4-page folder on the application of Cerromatrix in making chuck jaws easily and economically.

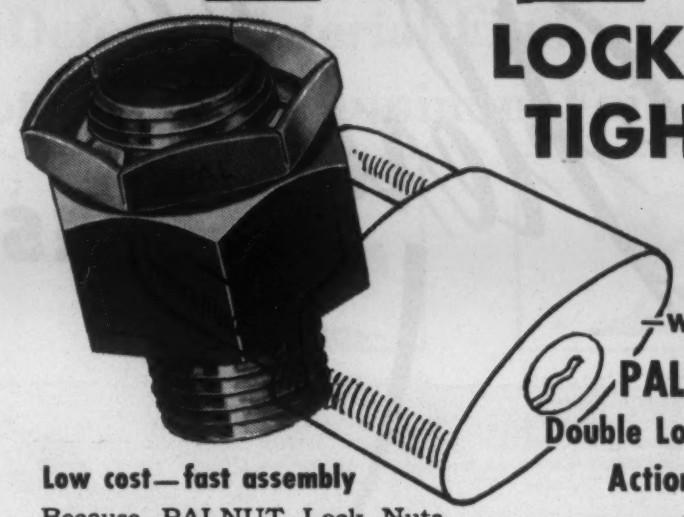
☐ Single sheet giving physical properties and data of Cerro Alloys.

CERRO de PASCO Corporation

Formerly Cerro de Pasco Copper Corporation

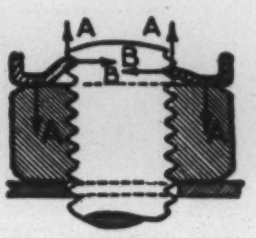
Dept. 8 • 40 Wall Street • New York 5, N. Y.

Both Nut and Bolt are LOCKED TIGHT



Low cost—fast assembly

Because PALNUT Lock Nuts apply on top of ordinary nuts, there are no interfering parts within the nut or between the nut and load to prevent or retard the full application of bolt stress for maximum bolt loading efficiency. A properly tightened nut, locked with a PALNUT, provides a completely vibration-proof, rugged assembly which stays trouble-free during the entire life of your products.



Powerful spring tension (A-A) is exerted upward on the bolt threads and downward on the ordinary nut, while slotted jaws (B-B) close in and grip the bolt like a chuck.

PALNUT
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LOCK NUTS

Write for samples and data

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REFERENCE DATA
for Designers and Fabricators
of PRESSURE VESSELS, TANKS, etc...
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WELDING NECKS
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PRESS FORMED PARTS AND PRESSURE VESSEL SPECIALTIES

60 pages of complete basic data, dimensions, pressure ranges, styles and types, code requirements, applications, and valuable handbook reference material. A copy of Lenape Catalog 949 will be sent upon request on company letterhead.

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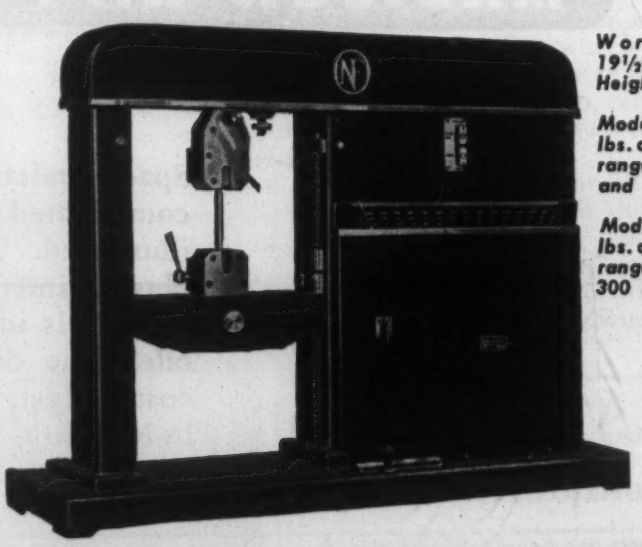
DEPT. 112 WEST CHESTER, PA.

RED MAN PRODUCTS

TEST IT IN YOUR OWN SHOP with the NEW NATIONAL FORGE UNIVERSAL TESTING MACHINE

TENSION — COMPRESSION — FLEXURE — SHEAR



Working Clearance 19½"; Stroke 16"; Height 44".

Model TMU-A—30,000 lbs. capacity with low range scales of 6000 and 600 lbs.

Model TMU-B—15,000 lbs. capacity with low ranges of 3000 and 300 lbs.

The compact, new Table Model Universal (TMU) Testing Machines have a rugged, simplified and dependable weighing system. A.S.T.M. accuracy is guaranteed. Infinitely-variable loading rates are applied thru unique ball-bearing screws and nuts, insuring fluid-smooth stressing at all speeds. Complete line of accessories available. Prompt Deliveries of Few Units Remaining in Stock.

Moderate Cost—Economy in Maintenance

Write for Brochure 501

Testing Machine Division

NATIONAL FORGE AND ORDNANCE CO.

Dept. MM, Irvine, Warren Co., Pennsylvania

Electric Brazing and Sintering Furnace by HARPER

equipped with

GLOBAR Heating Elements

by

CARBORUNDUM
TRADE MARK

Provides 3-way Advantage

1. Performance

Maximum brazing efficiency, dependable operation and low maintenance costs for extended periods highlight a list of advantages including fast heating, accurate temperature control and uniform work chamber temperatures.

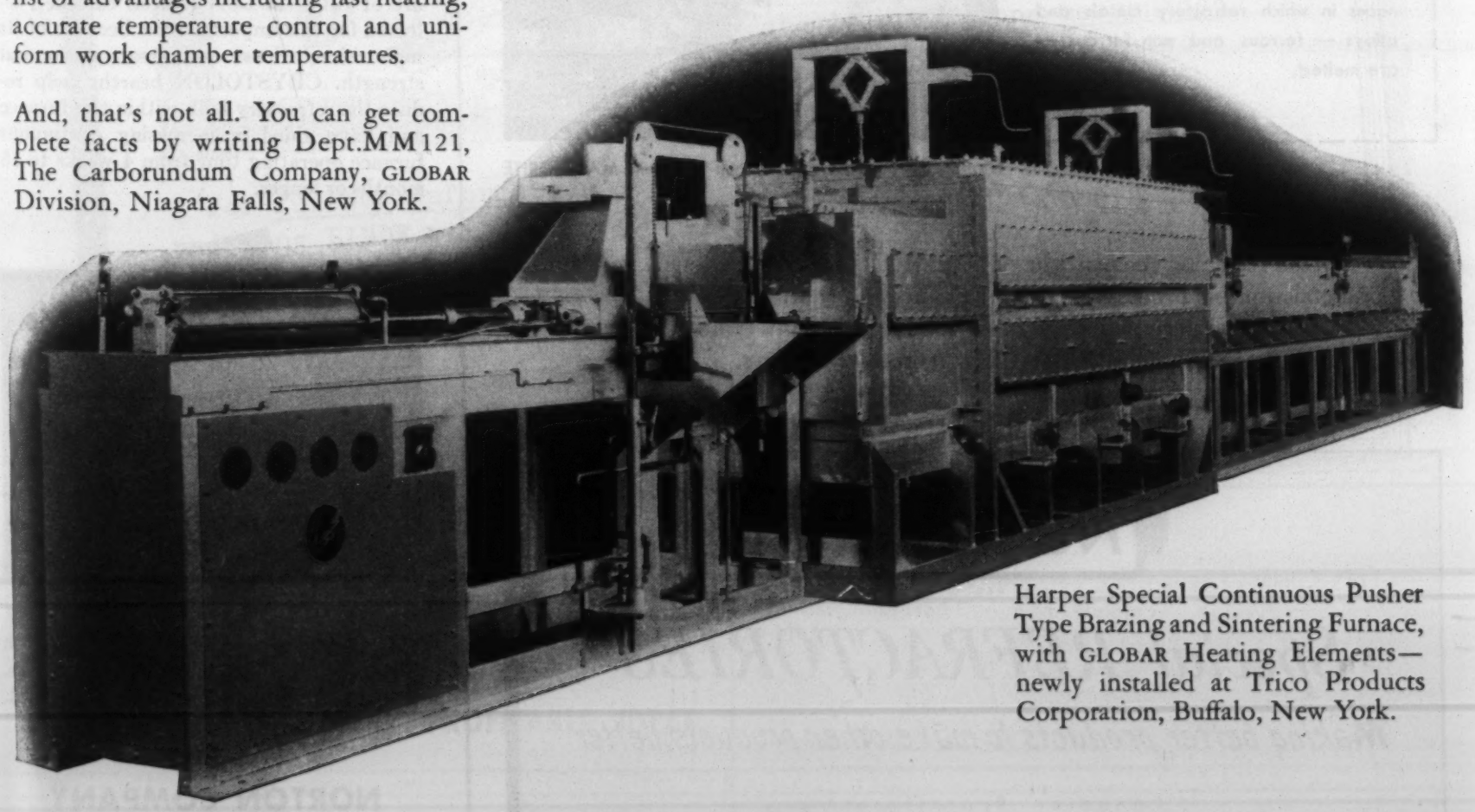
And, that's not all. You can get complete facts by writing Dept.MM121, The Carborundum Company, GLOBAR Division, Niagara Falls, New York.

2. More Efficient Furnace Design

Made possible by rod-shaped GLOBAR silicon carbide elements which permit larger work chamber space.

3. Easy Maintenance

Elements are interchangeable . . . can be replaced easily, without shutting down furnace.



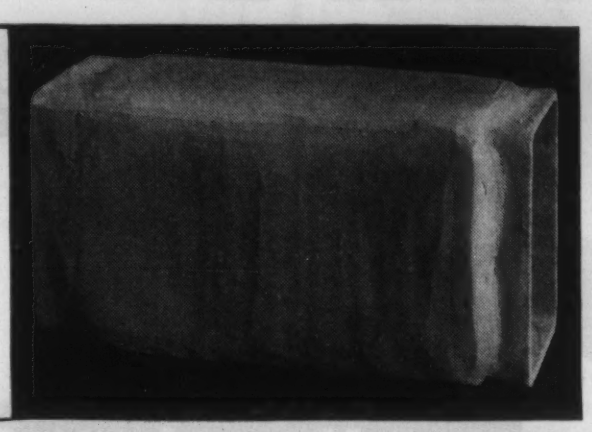
Harper Special Continuous Pusher Type Brazing and Sintering Furnace, with GLOBAR Heating Elements—newly installed at Trico Products Corporation, Buffalo, New York.

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company

87-73

Three Refractory Cements For Lower-Cost Heat-Control

ALUNDUM* CEMENT — Electrically fused alumina in its most dense and unshrinkable form. Its high refractoriness, electrical resistivity, thermal conductivity and resistance to oxidation make it ideal for embedding electrical resistors, ramming burner blocks, setting bricks and lining certain metal melting furnaces.

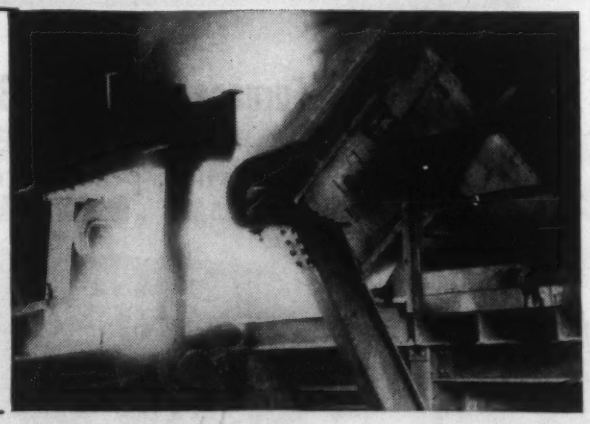


Resistor around muffle imbedded in ALUNDUM cement

CRYSTOLON* CEMENT — A silicon carbide product that is an excellent heat conductor and highly resistant to spalling, slag adherence and penetration. Especially suitable for lining and patching non-ferrous metal melting furnaces and laying brick in zinc and zinc oxide furnaces.

Pit furnaces lined with Norton CRYSTOLON cement

MAGNORITE* CEMENT — Electrically fused magnesia and one of the most refractory oxides commercially available. Has high resistance to basic slags and is recommended for lining induction furnaces in which refractory metals and alloys — ferrous and non-ferrous — are melted.



High frequency induction furnace lined with MAGNORITE cement

Norton refractory cements have been developed to meet a wide variety of metal-working processes involving the use and control of heat. A Norton refractories engineer will be glad to specify the right cements for your applications. NORTON COMPANY, Worcester 6, Mass.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries.

NORTON

TRADE MARK REG. U. S. PAT. OFF.

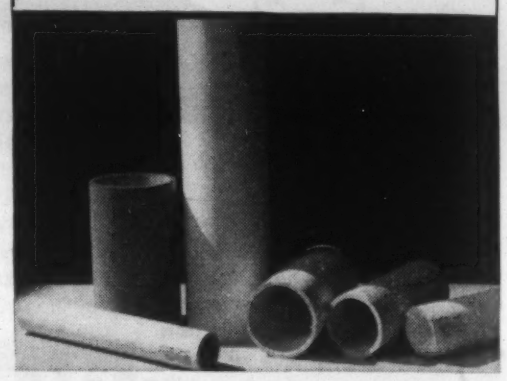
Special REFRACTORIES

Making better products to make other products better

Canadian Representative

A. P. GREEN FIRE BRICK CO., Ltd. TORONTO, ONTARIO

For high temperature furnaces... Super-Duty ALUNDUM Tubes

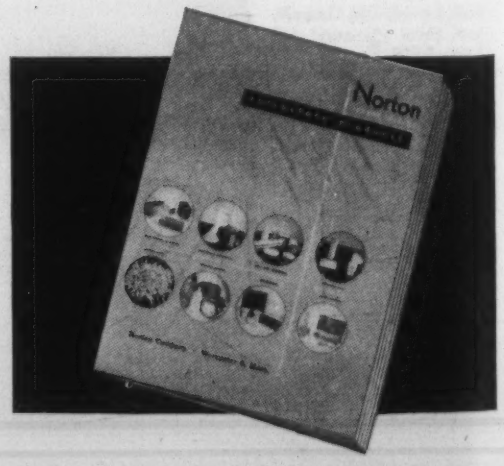


Norton keeps pace with steadily increasing temperatures in heat treating and sintering processes with a line of pure oxide refractories especially developed to withstand high heat.

Outstanding among these are ALUNDUM tubes (also cores and muffles) made of 99% fused alumina, providing excellent thermal conductivity and usable at temperatures up to 1950° C.

Norton Hearth Plates

are of CRYSTOLON (silicon carbide), selected for this important use because of its high refractoriness and great mechanical strength. CRYSTOLON hearths help reduce the refractory bulk within the furnace and have aided in increasing continuous furnace operating time from 4 weeks to 18 months or longer.



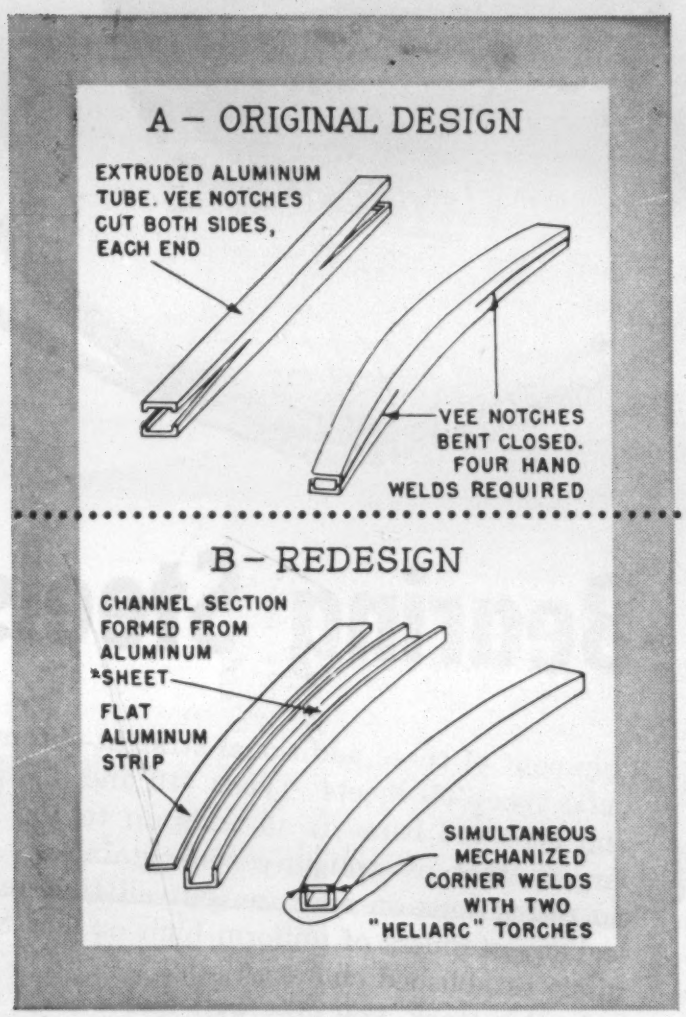
You'll find many helpful facts on Norton refractories, including bricks, burner blocks, cores and muffles in Bulletin 151. Write for it.

NORTON COMPANY
346 NEW BOND STREET
WORCESTER 6, MASS.

Ideas on Welded Design—For the Engineer's Notebook

CONCENTRATE ON CORNERS

Type and location of joints directly influence both welding method and difficulty of assembly. Edge welds and corner welds are generally easiest, quickest, and least costly to make, regardless of fusion welding method. By recognizing this simple fact, many production headaches can be avoided. For example:

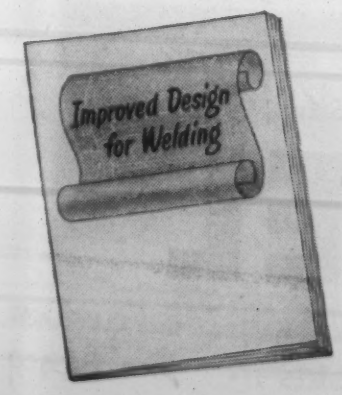


One manufacturer used to make legs for aluminum office chairs from sections of extruded tube. Ends were notched on both sides (sketch A), bent closed, and joined by means of four manual butt welds. Production by this method was slow, costs high.

A simple redesign of the part made it possible to speed up the welding, reduce finishing, and cut material costs substantially. Sketch B shows how sheet is now used instead of more expensive extrusions. Both corners of the new assembly are joined in one mechanized welding operation with two "HELIARC" Torches.

For further information about "HELIARC" welding and other cost reducing LINDE methods, phone or write LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N.Y. Offices in Other Principal Cities. In Canada: Dominion Oxygen Company, Limited, Toronto.

The term "Heliarc" is a registered trade-mark of Union Carbide and Carbon Corporation.



Mail this coupon for

MORE PROFITABLE IDEAS

LINDE AIR PRODUCTS COMPANY
30 East 42nd Street, New York 17, N.Y.

Please send me my free copy of 20-page booklet, F-7811, entitled "Improved Design for Welding."

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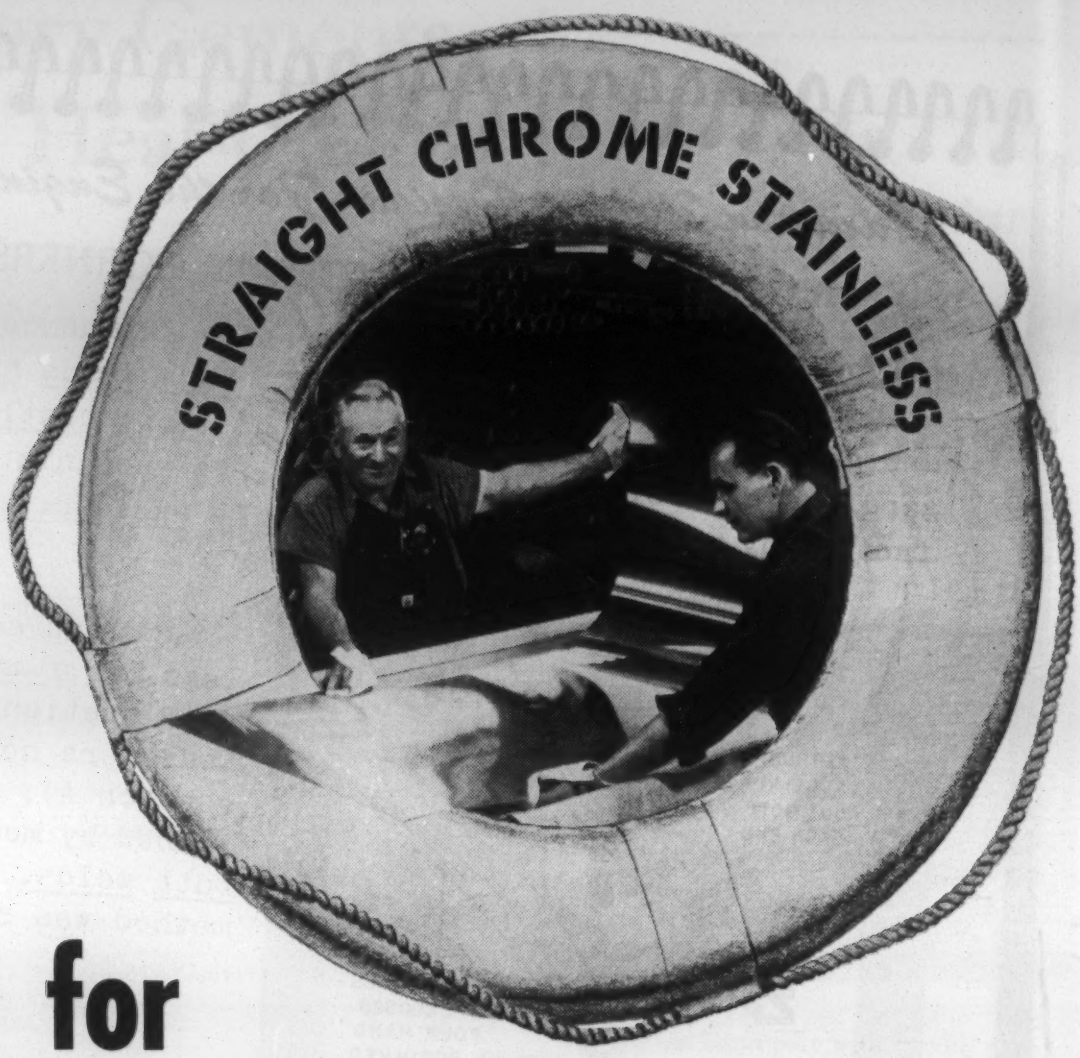
Company.....

Street Address.....

City.....Zone....State.....



Life-saver for Users of Nickel-Bearing Steels

If you are among those handicapped by government restrictions on nickel-bearing 18-8 stainless, large Ryerson stocks of straight chrome stainless may prove to be a life-saver. For example, many who formerly used type 302 sheets to meet mild corrosive action are finding a practical alternate in type 430. And this 17% chrome stainless is on hand now —ready for immediate delivery from your nearby Ryerson plant.

You can order type 430 sheets from Ryerson in all gauges from 10 to 26, in No. 2B or No. 4 finish—and in almost any quantity. You can also get quick shipment of these additional straight-chrome products: type 405 sheets—types 410 and 430 plates—and type 416 bars. It all adds up to the nation's largest stock of straight-chrome stainless. All with no restrictions on end use, but all time-tested Allegheny stainless of uniform high quality and definitely established characteristics.

In this stock, you may well find a steel that will enable you to maintain satisfactory quality in your product until nickel-bearing steels are again available. So now for stainless, we urge you to consider the versatile chromium stainless steels in Ryerson stock.

RYERSON CERTIFIED STEELS

WRITE FOR HELPFUL DATA—*On Type 430 and Other Chrome Stainless*

To help you convert to chrome stainless, we shall be glad to send an authoritative bulletin on the mechanical properties, corrosion resistance, weldability, etc., of these steels as compared with 18-8 stainless. Write for your copy. And remember that the advice of Ryerson stainless specialists is always yours for the asking. We suggest you discuss your chrome stainless problems with us.

National Warehouse Distributor of Allegheny Stainless in All Types, Shapes and Sizes

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JOSEPH T. RYERSON & SON, INC. PLANTS AT: NEW YORK • BOSTON • PHILADELPHIA • CINCINNATI • CLEVELAND
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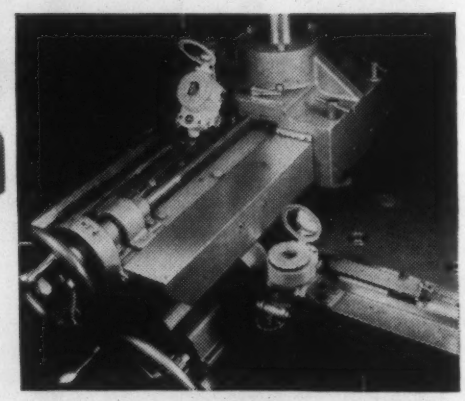
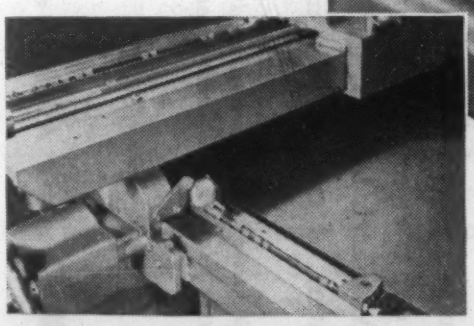
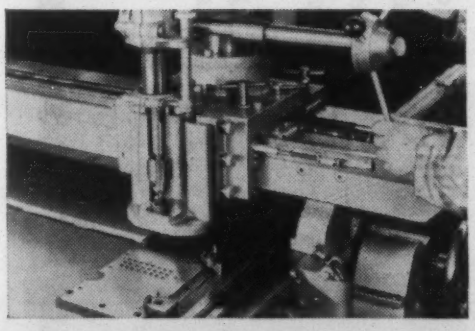
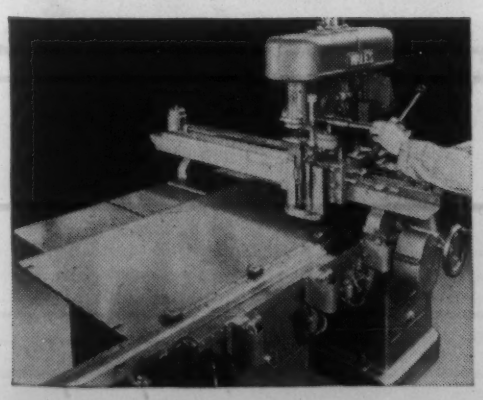
IN A CLASS BY ITSELF









LOCATING . . . Holes are located by placing end measures in V-grooves on bridge and slide rail (or by using a precision optical gage as shown in extreme right illustration). Two speed gearing on both front-to-back and right-to-left settings provide rapid traverse for rough positioning and slow speed for "zeroing in". Air locking clamps are provided for rigid positioning on both horizontal and longitudinal planes.

DRILLING . . . Showing typical small template being drilled with drill head assembly and slide rail locked in position by air clamps.

REAMING . . . Showing hole in large template being reamed by simply interchanging the drill and bushing with corresponding size reamer and reamer bushing.

WALES
DRILLING MACHINE
For Precision Locating, Drilling and Reaming of Holes

● This exclusive Wales Drilling Machine fills a definite need. *There is no other drilling machine or jig borer like it.*

Accuracy is the primary consideration in building this specially designed and ruggedly constructed Wales Drilling Machine which combines simplicity of operation, easier locating and faster production.

The illustrations at left show *how this Wales Drilling Machine operates.* Conveniently located built-in 1/32" scales and dial-type gages calibrated in ten thousandths of an inch accurately locate drill head and slide rail.

For the complete story on Wales Drilling Machine, write TODAY for fully-illustrated, functionally-colored Catalog DM.

WALES-STRIPPIT CORPORATION
GEORGE F. WALES, *Chairman*
399 PAYNE AVE., NORTH TONAWANDA, N. Y.
(Between Buffalo and Niagara Falls)
WALES-STRIPPIT OF CANADA LTD., HAMILTON, ONTARIO

Specialists in Punching and Notching Equipment

These MONARCH-MEN are ready to serve you...NOW!

These carefully selected Monarch-Men are located in the heart of industry's busiest areas.

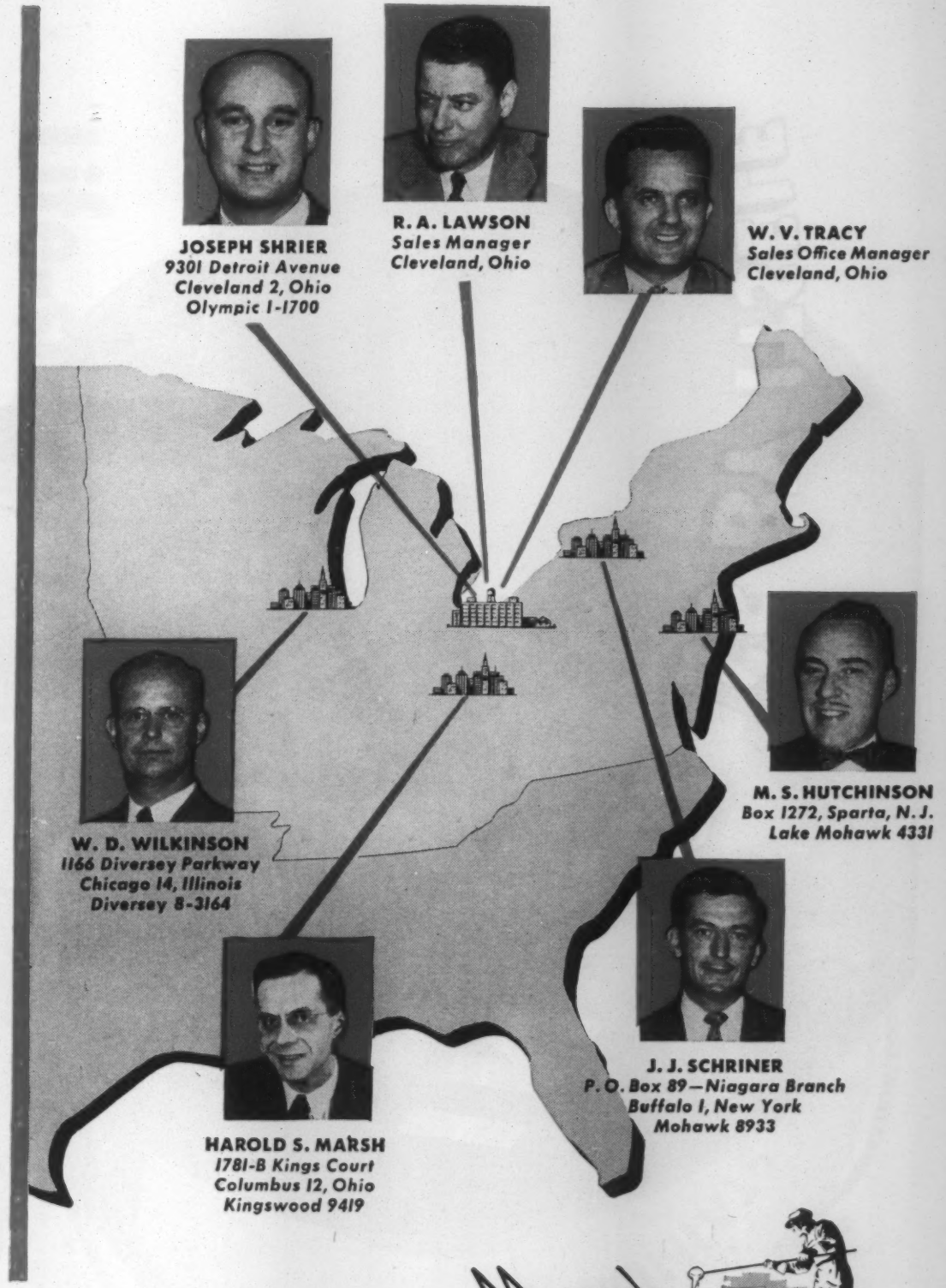
They offer expert analysis...production experience and practical assistance should any trouble develop.

They are exclusively Monarch-employed, trained in aluminum permanent mold, aluminum and zinc die casting production methods.

Meet your Monarch-Man... get to know him well. Let him help you solve difficult production problems with Monarch's proved facilities for casting, finishing and complete product assembly... all in one modern plant.

You can depend upon your Monarch-Man. He represents 38 years of experience that the men and women at Monarch have contributed to the advancement of the casting industry.

Reprints of this advertisement for your source file are available upon request.



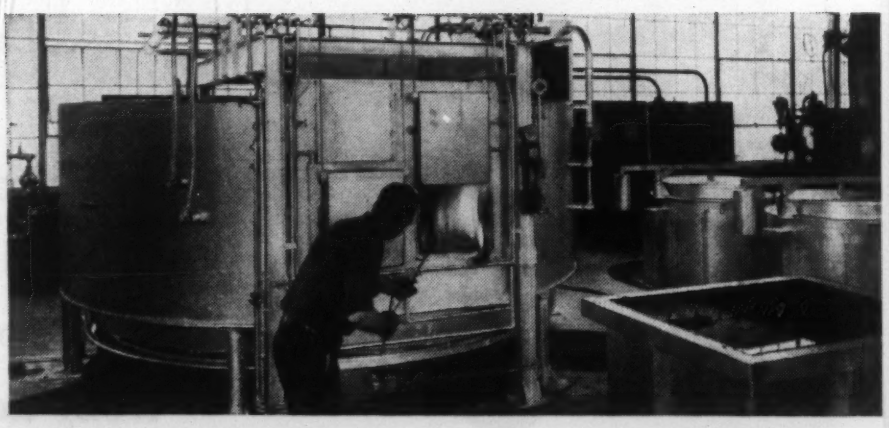
MONARCH ALUMINUM MFG. COMPANY • *Detroit Avenue at West 93rd Street, Cleveland 2, Ohio*

oller-hearth furnace for high-production continuous brazing of bomb-casing assemblies, annealing shell casings and hardening and drawing jet engine part

Get High Speed Heat-treating for Your Defense Production

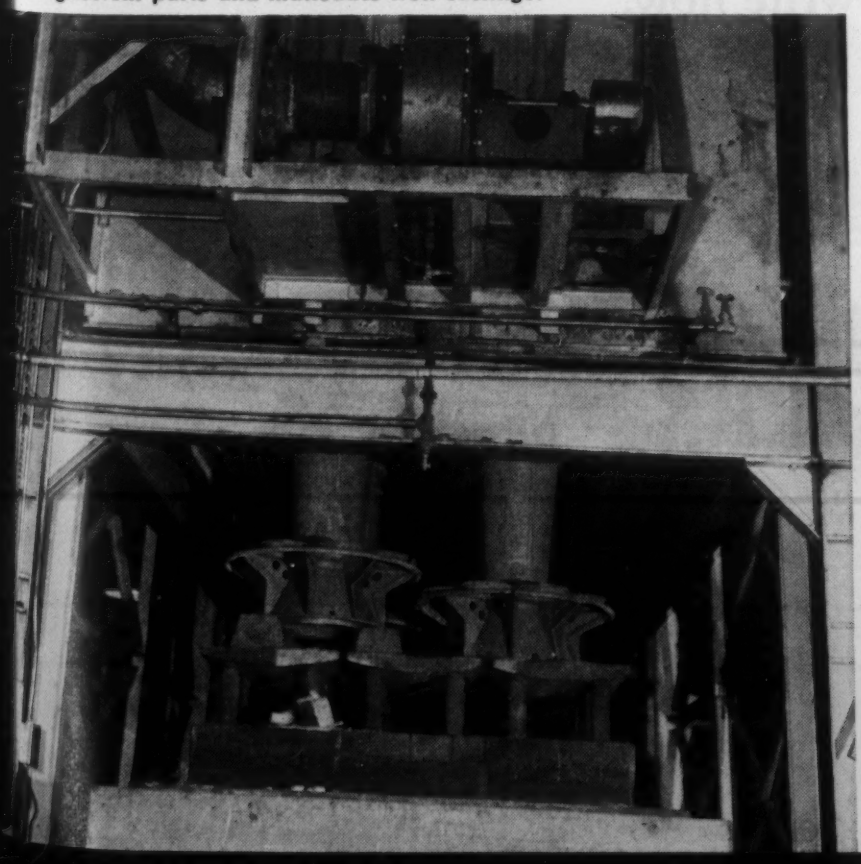
Defense equipment manufacturers are achieving fast production, low over-all cost and high quality products with dependable G-E electric furnaces. And you can benefit in the same way . . . draw on G.E.'s *tested designs* and broad experience from building furnaces since World War I . . . know that your new furnace is dependable during this vital work . . . and will serve you just as ably when you again produce civilian goods.

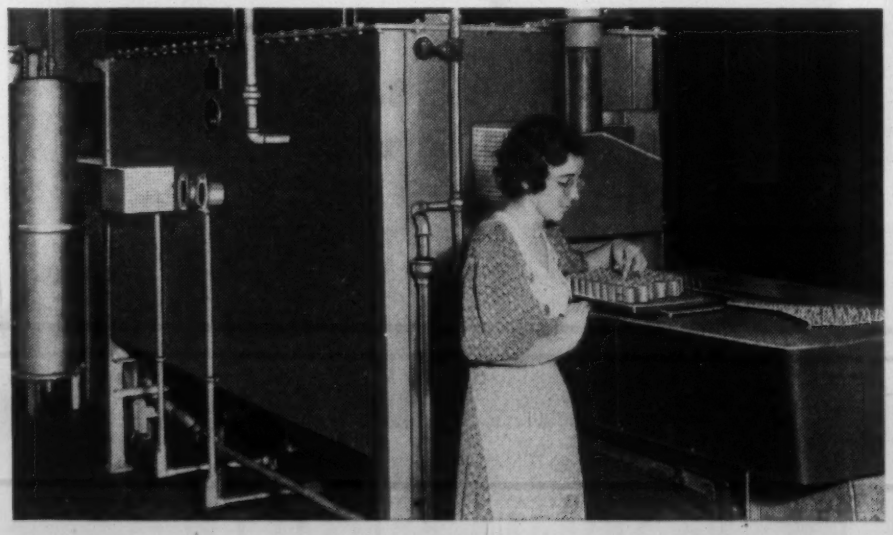
Present your heat-treating application to the nearby G-E Sales Office, or write to: Sect. 720-50, General Electric Co., Schenectady 5, N. Y.



Rotary-hearth furnace for heating parts which require individual handling such as hardening gears and projectiles and forging jet engine blades.

Elevator furnaces for annealing stainless steel assemblies, aluminum and magnesium parts and malleable iron castings.

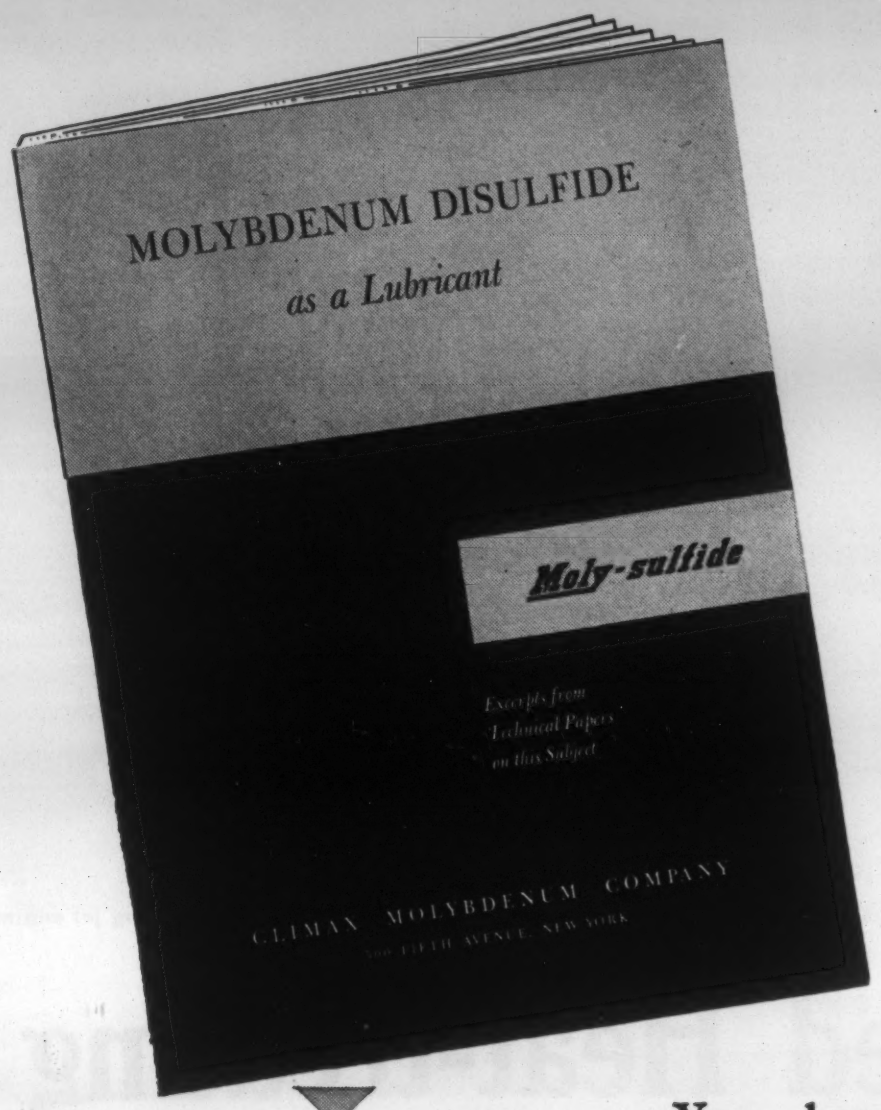




Mesh-belt-conveyor furnace for accurate, automatic furnace-brazing, bright-annealing and sintering of small parts.

GENERAL ELECTRIC

720-50



What do you know about MoS_2* as a lubricant?

* Molybdenum disulfide

You have probably heard reports, some enthusiastic, some conservative, of the remarkable properties of Molybdenum Disulfide as a new lubricant.

For those who wish to review published information on this subject, we have compiled a 55 page publication containing excerpts from authoritative technical papers. Copies are free—write now.

Please send your FREE Booklet
"MOLYBDENUM DISULFIDE AS A LUBRICANT"
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MS1

THE All New OLSEN MODEL 51
ELECTRONIC RECORDER

(with atcotran)

For Stress-Strain Work in Tension, Compression, Flexure, and special applications

- ★ Unexcelled Accuracy*
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- ★ Simplified Controls and Instrumentation
- ★ No Gear changes—change magnification by flipping a switch
- ★ Response—full chart 4 seconds
- ★ Letter sized Curves
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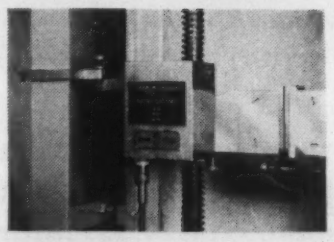
*All Olsen Recorders, Instruments, and Motion Detectors are calibrated to linear standards.

Standard S-Type Extensometer



Standard Strain Instrument Type C-1 Deflectometer and Crosshead.

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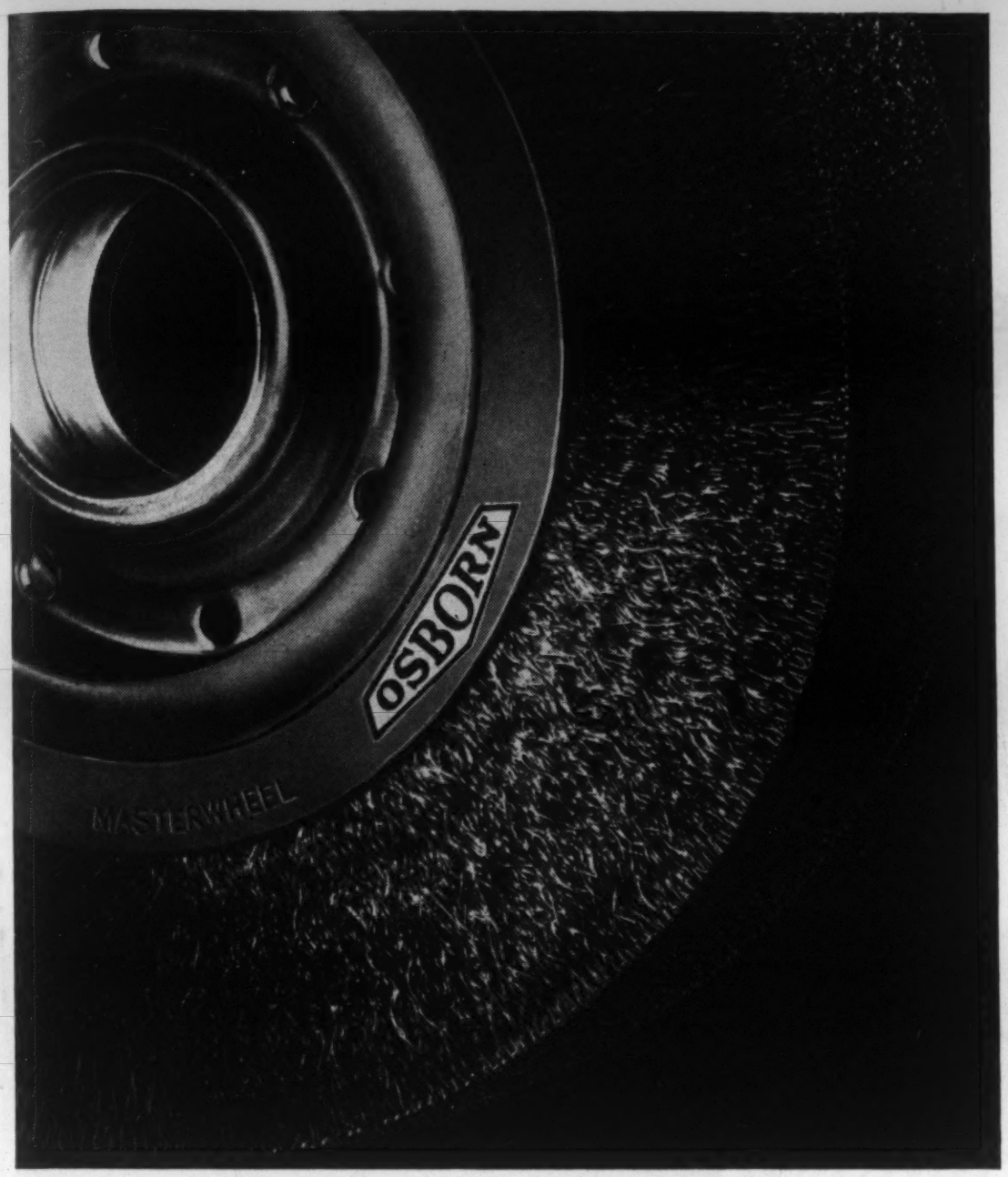
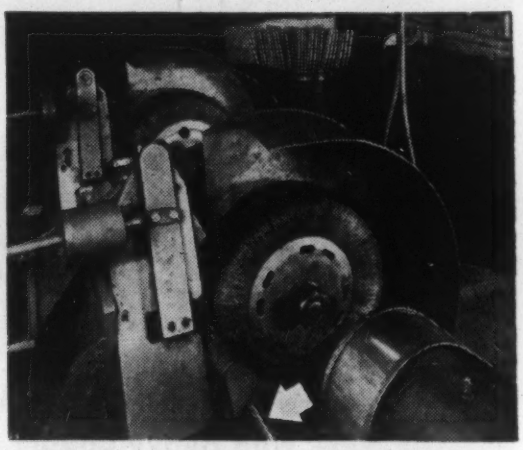


DEBURRING OUTPUT TRIPLED. That's the production increase in this plant using Osborn Power Brushing for the removal of burrs from clutch discs. And quality of finish is greatly improved.



FINISHING OUTPUT UP 20%. Osborn Power Brushing removes heat-treat discolorations and surface imperfections of these shafts prior to plating. Cut number of passes from two to one, increasing output 20%.

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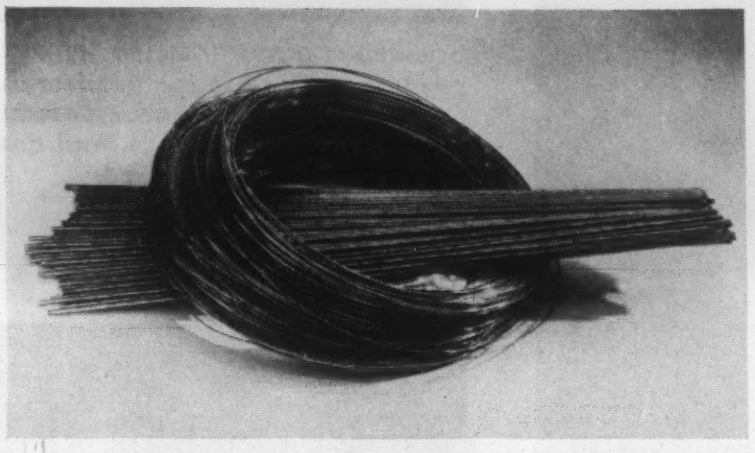

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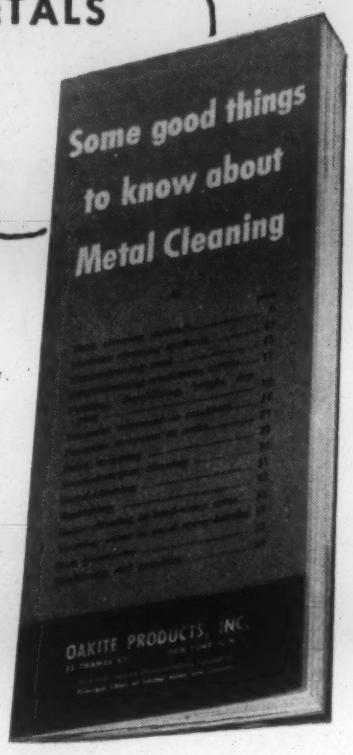

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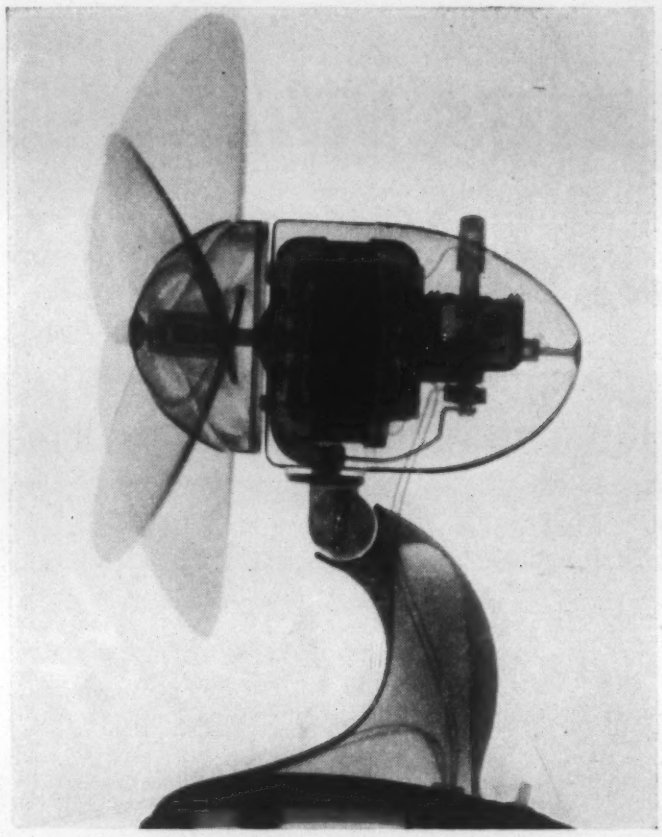

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*** An actual case history from the Allis-Chalmers Pittsburgh Works, manufacturers of transformers.**

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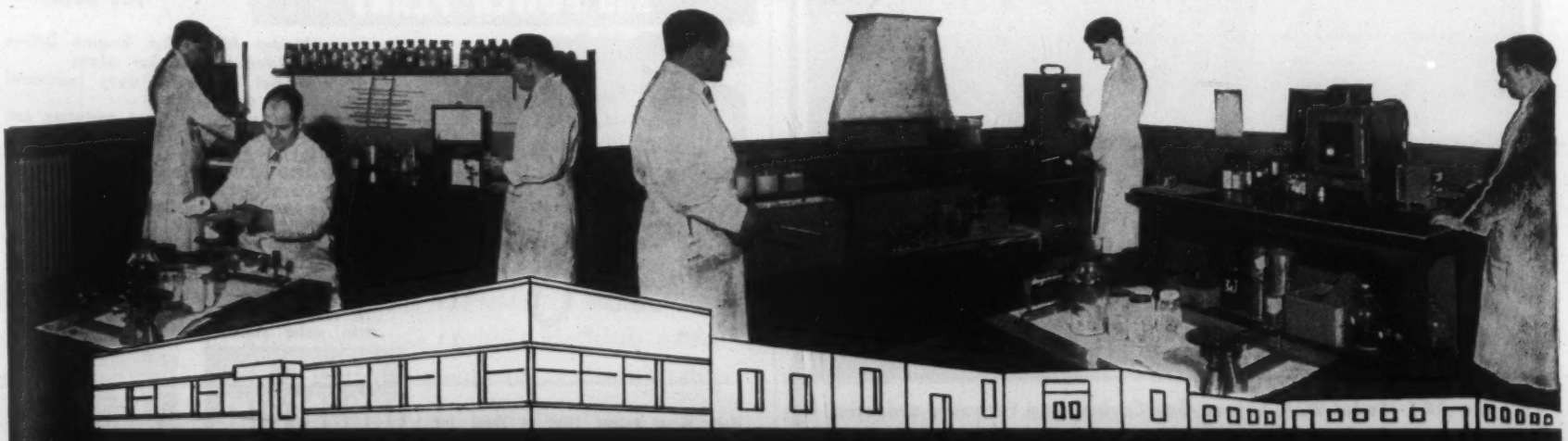

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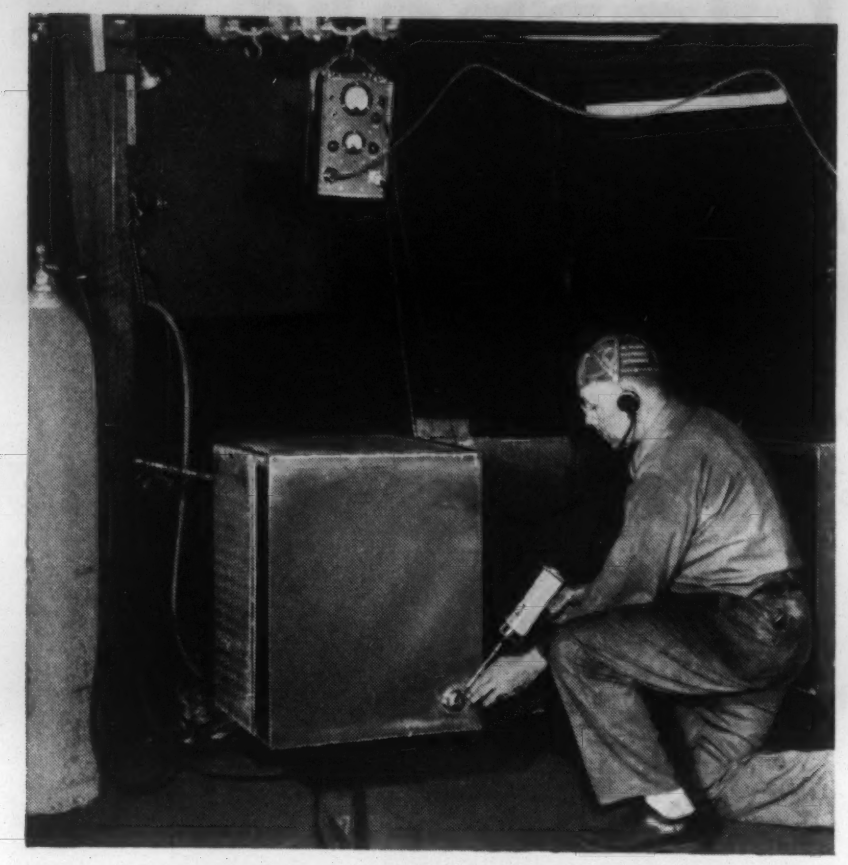

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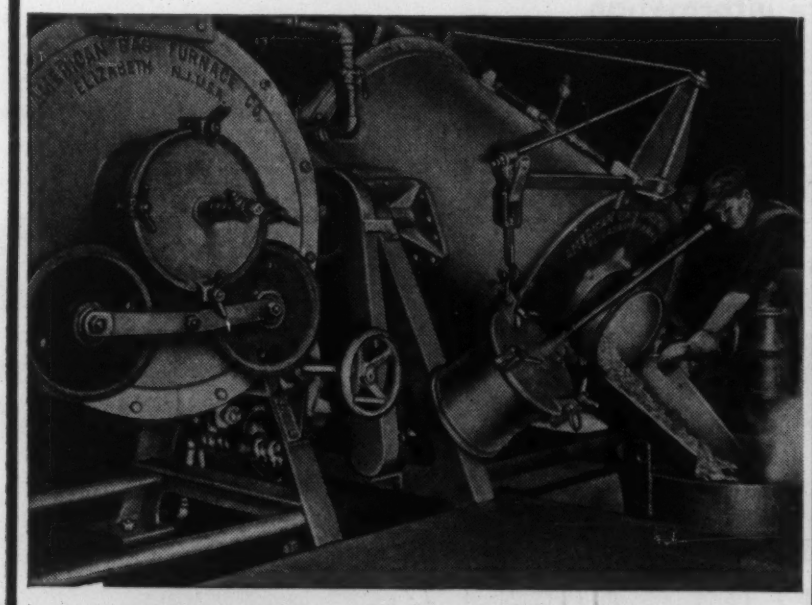

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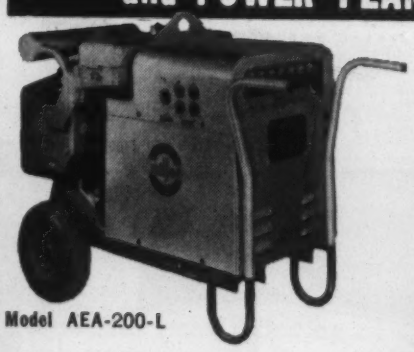

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- **Model 88 heavy duty Industrial A.C. welder**

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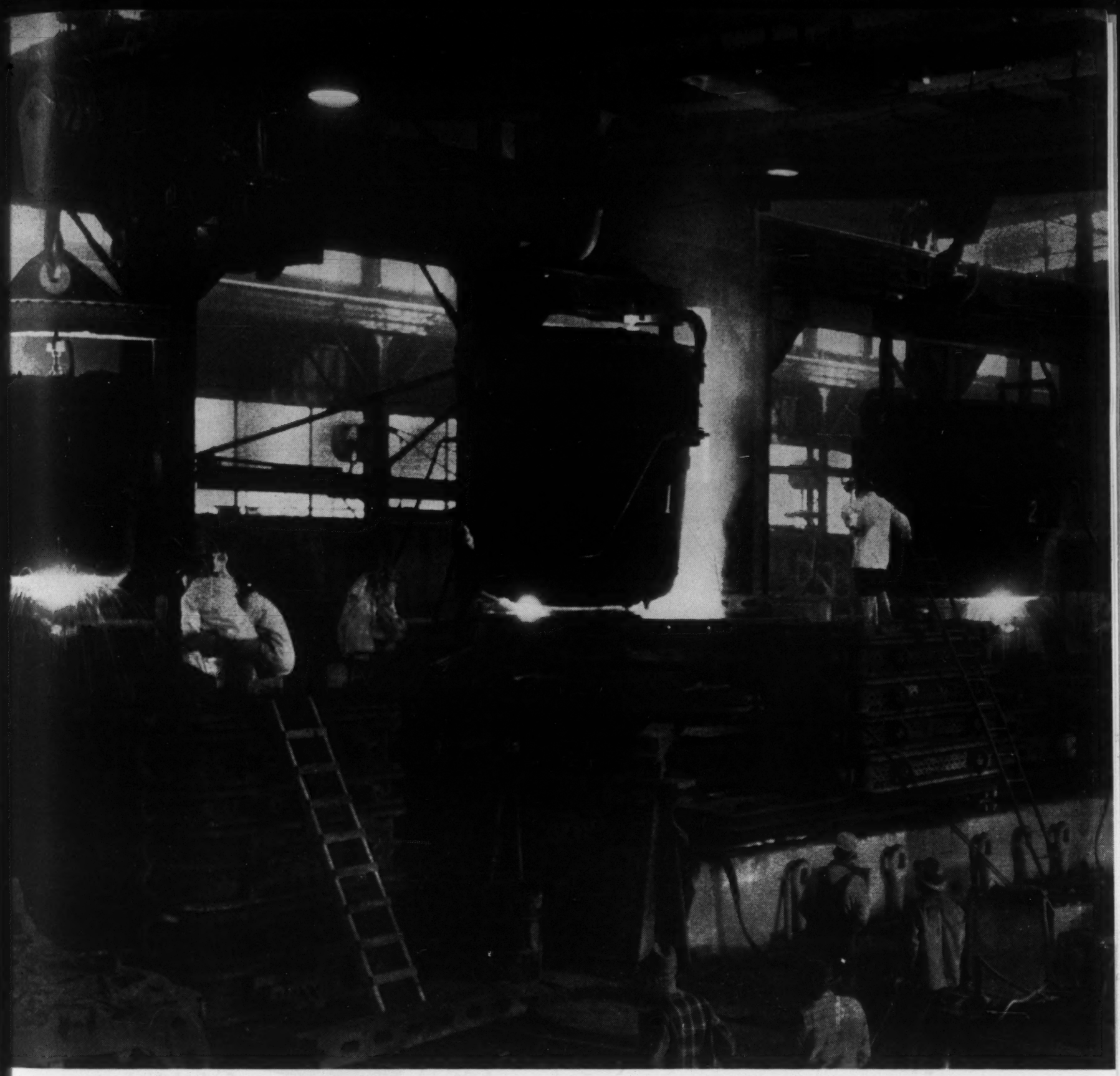

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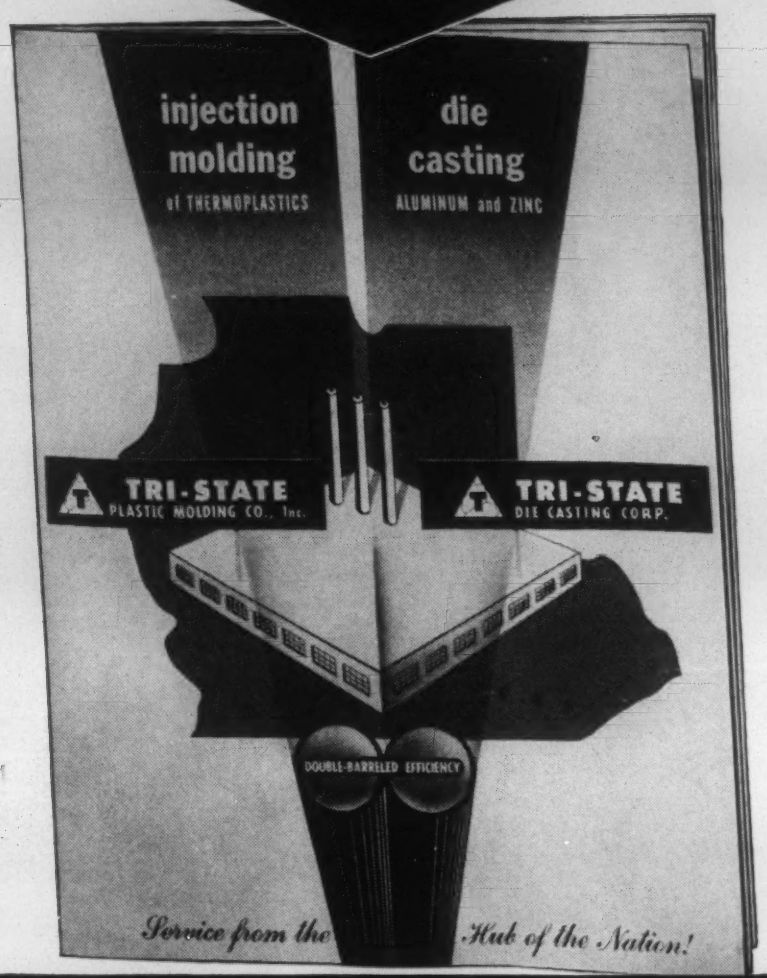

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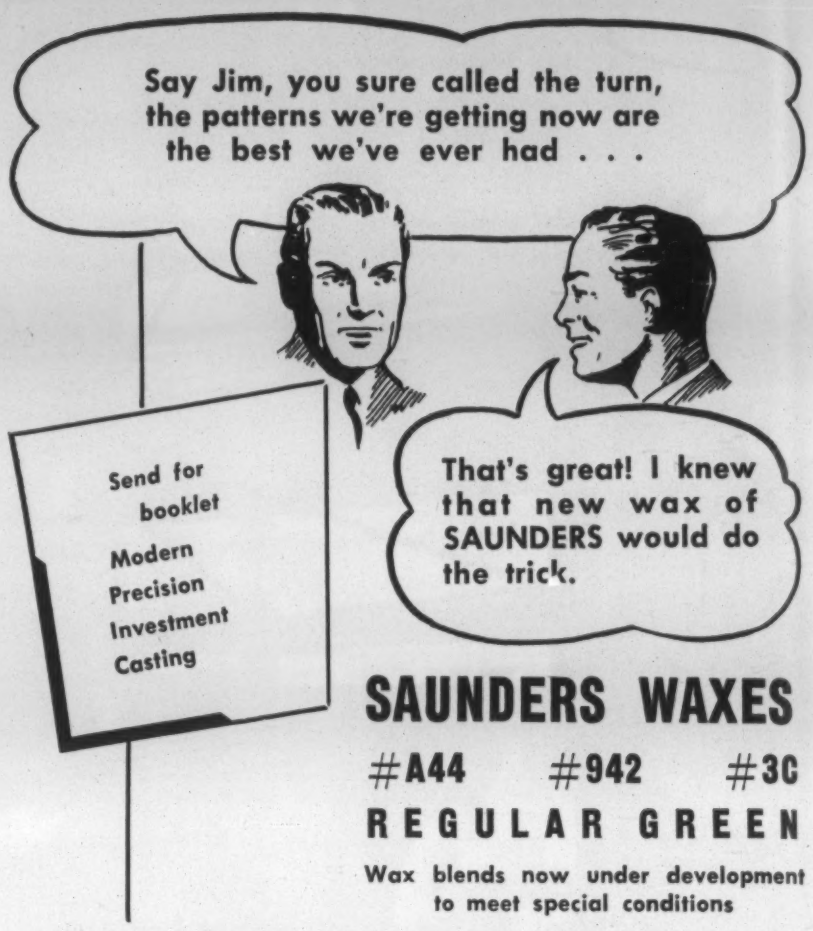

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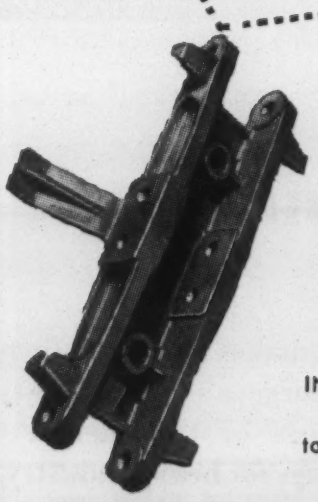

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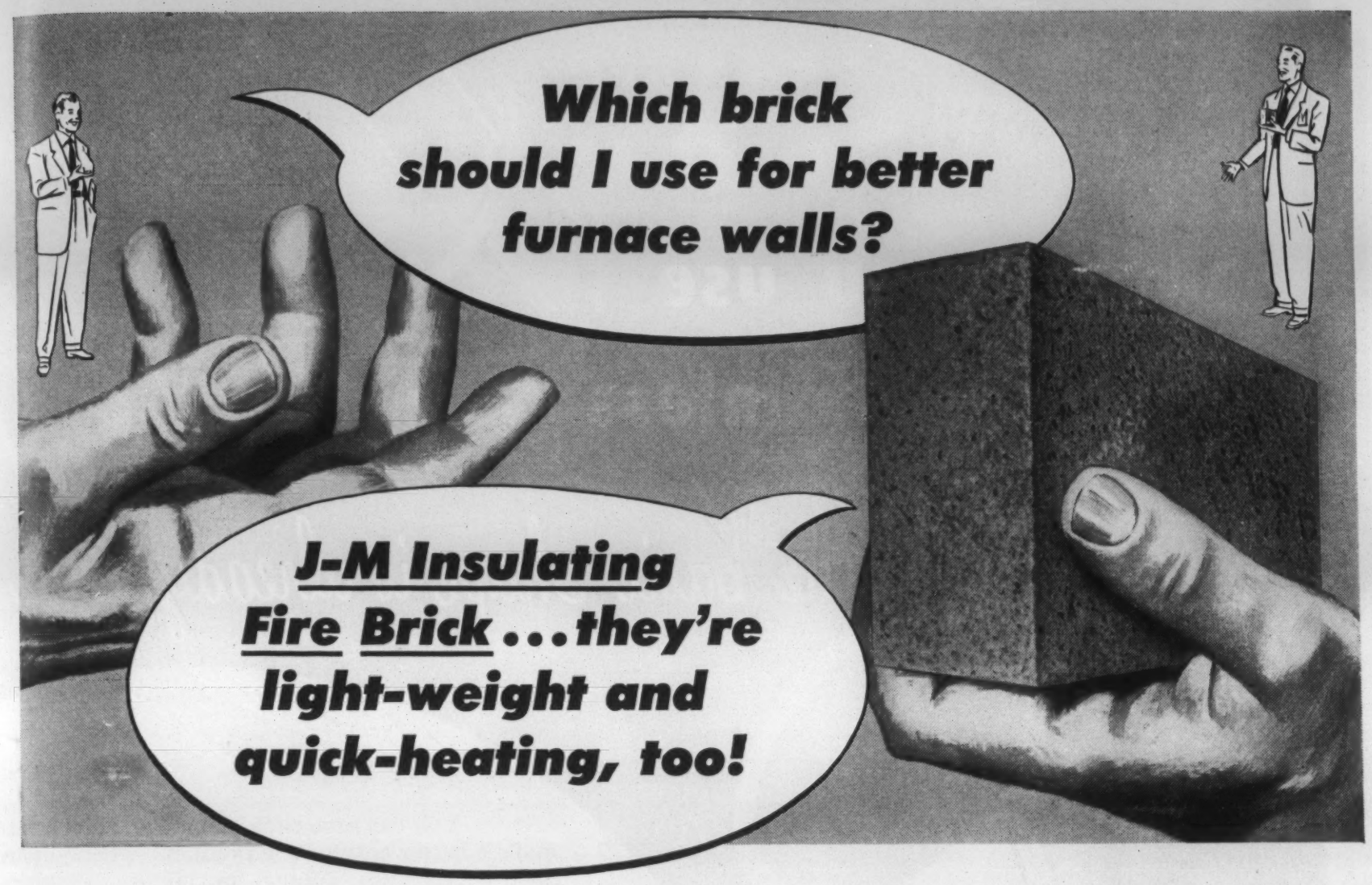

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Identical materials can also be obtained in large size units known as Johns-Manville Insulating Fireblok. Fireblok have the same properties as the brick, but are made in extra large sizes for added construction economies. The large units can be installed faster . . . require fewer joints and less bonding mortar. During rebuilding or repair, furnace down-time is appreciably shortened with Fireblok construction.

A Johns-Manville insulation expert will gladly explain the advantages and economies of using J-M Insulating Fire Brick and Fireblok for refractory linings or as back-up insulation behind other refractory protection. Write to Johns-Manville, Box 290, New York 16, N. Y. In Canada, write 199 Bay St., Toronto 1, Ontario.

Properties	Types of Insulating Fire Brick and Fireblok					
	JM-3000	JM-28	JM-26	JM-23	JM-20	JM-1620
Temperature limit	†3000F	†2800F	†2600F	†2300F	†2000F	‡2000F †1600F
Density, lb per cu ft	63—67	58	48	42	35	29
Transverse strength, psi	200	120	125	120	80	60
Cold crushing strength, psi	40	150	190	170	115	70
Linear shrinkage, percent	*0.8 at 3000F	4.0 at 2800F	1.0 at 2600F	0.3 at 2300F	0.0 at 2000F	0.0 at 2000F
Reversible thermal expansion, percent	0.5—0.6 at 2000F	0.5—0.6 at 2000F	0.5—0.6 at 2000F	0.5—0.6 at 2000F	0.5—0.6 at 2000F	0.5—0.6 at 2000F
Conductivity (Btu in. per sq ft per F per hr at following mean temperatures)						
500F	3.10	2.00	1.92	1.51	0.97	0.77
1000F	3.20	2.50	2.22	1.91	1.22	1.02
1500F	3.35	3.00	2.52	2.31	1.47	1.27
2000F	3.60	3.50	2.82	2.70	1.72	....

*24-hr Simulative Service Panel Test; all others 24-hr soaking period. †Back-up or exposed. ‡Back-up only.

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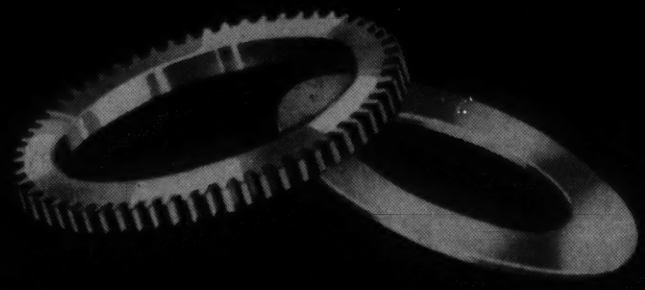
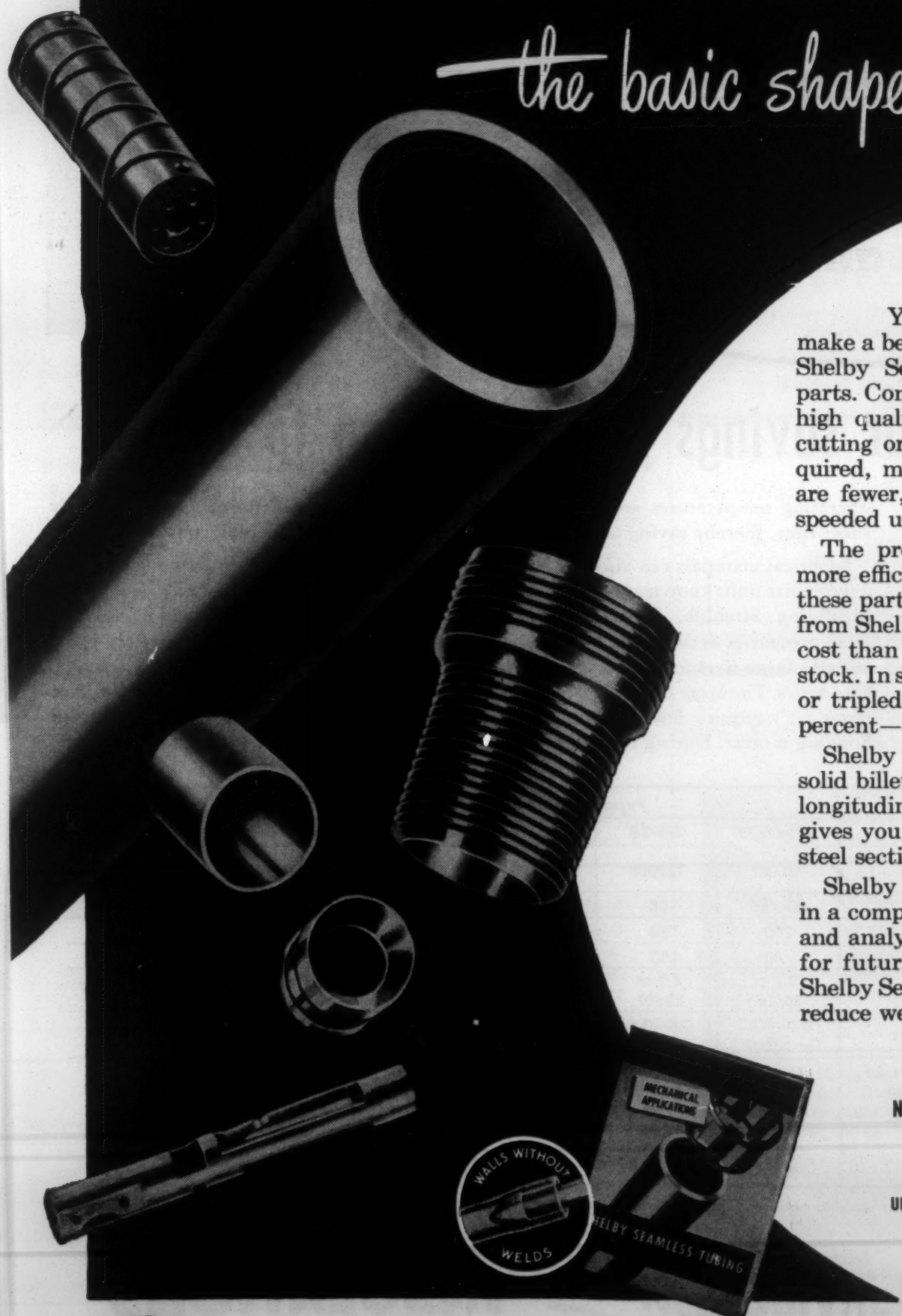


When you use Shelby Seamless

—the basic shape is already made



You can save time, money and steel—and make a better automotive product—when you use Shelby Seamless Tubing for hollow cylindrical parts. Compared to solid bar stock or forgings, this high quality seamless tubing requires much less cutting or boring. Since fewer operations are required, man and machine hours are less, rejects are fewer, production of all automotive parts is speeded up.

The products shown here are typical of this more efficient method of manufacturing. Some of these parts are quite complex, but each was made from Shelby Seamless Tubing, faster and at lower cost than identical parts machined from solid bar stock. In several cases production has been doubled or tripled—costs savings have run as high as 50 percent—rejects have been reduced to zero.

Shelby Seamless Steel Tubing is pierced from a solid billet of quality steel. As a result, there is no longitudinal weld to weaken the tube. This process gives you the strongest, most dependable tubular steel section that money can buy.

Shelby Seamless Steel Tubing is manufactured in a complete range of diameters, wall thicknesses and analyses to meet every need. When you plan for future automotive applications, remember Shelby Seamless for its ability to increase strength, reduce weight and cut your production costs.

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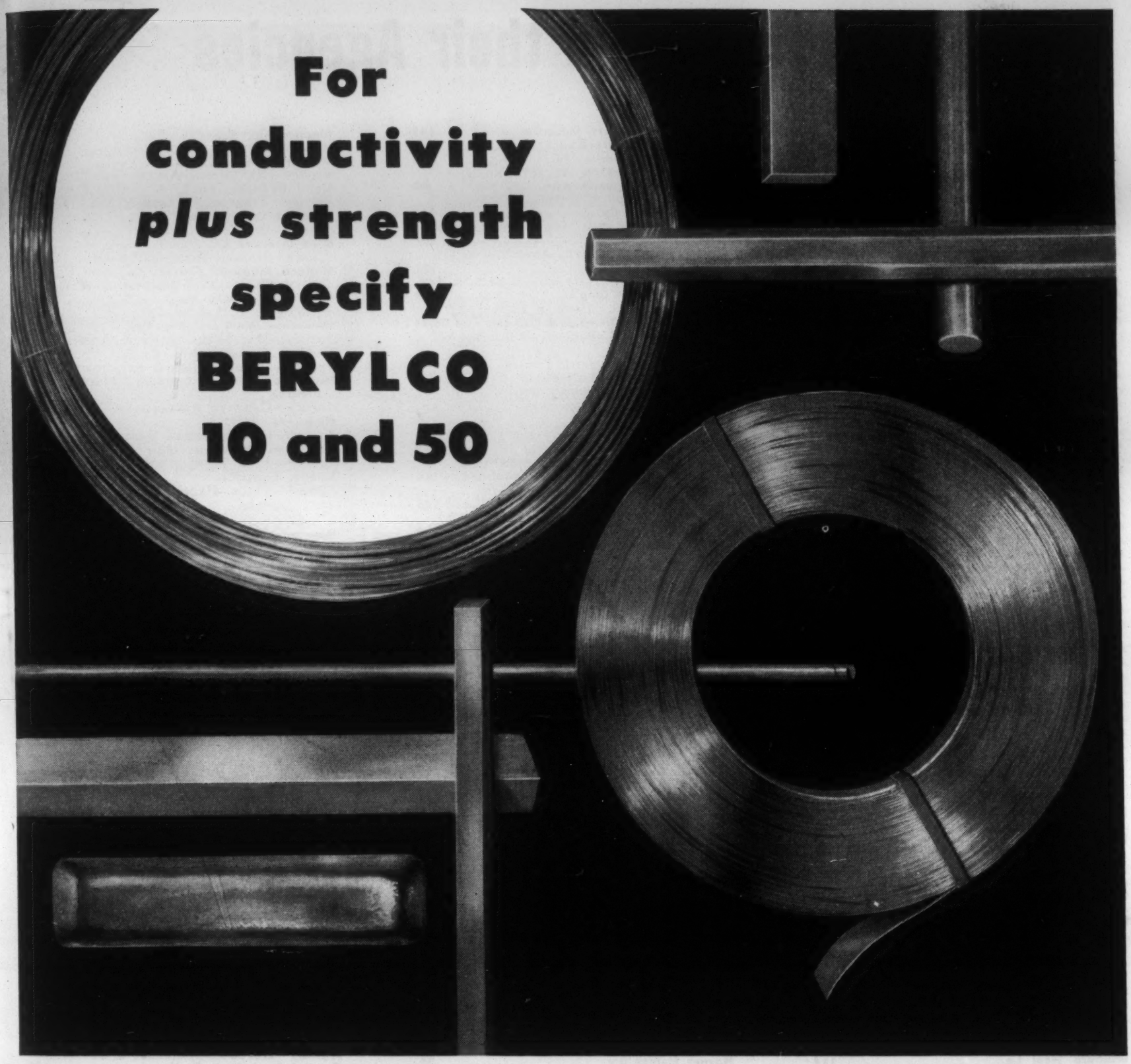
UNITED STATES STEEL



Need a current-carrying material which is harder than copper, with greater resistance to wear? Investigate Berylco beryllium copper.

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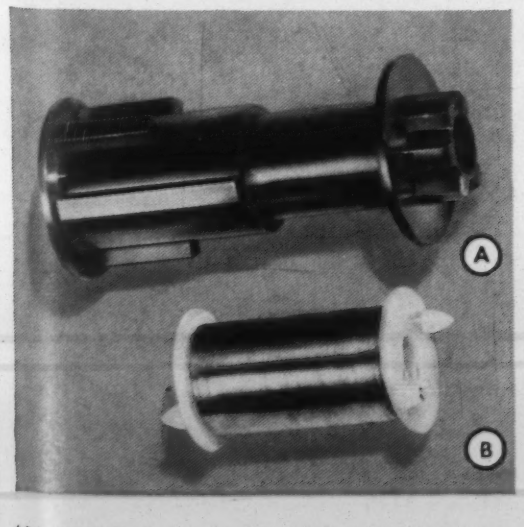

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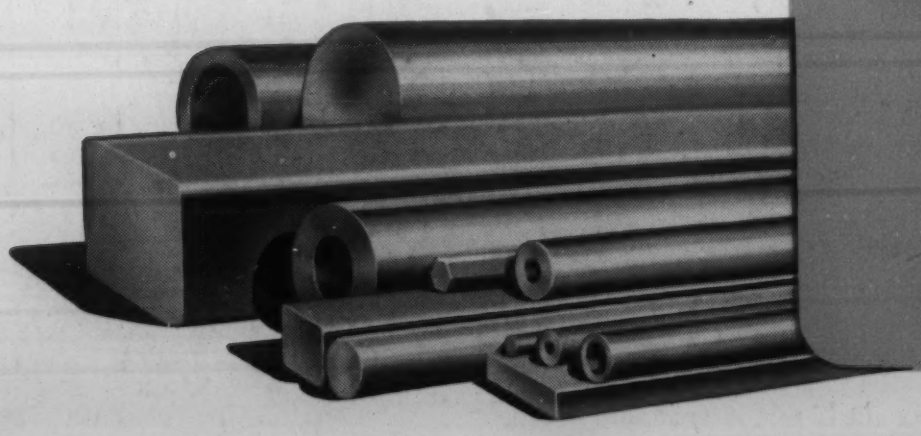

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